the Cornell engineer

Shippingport:

The Nation's First Commercial Atomic Power Plant

N. S. Savannah:

The World's First Nuclear-Powered Surface Ship

COLLEGE OF ENGINEERING
JANUARY, 1959 VOL. 24, NO. 4

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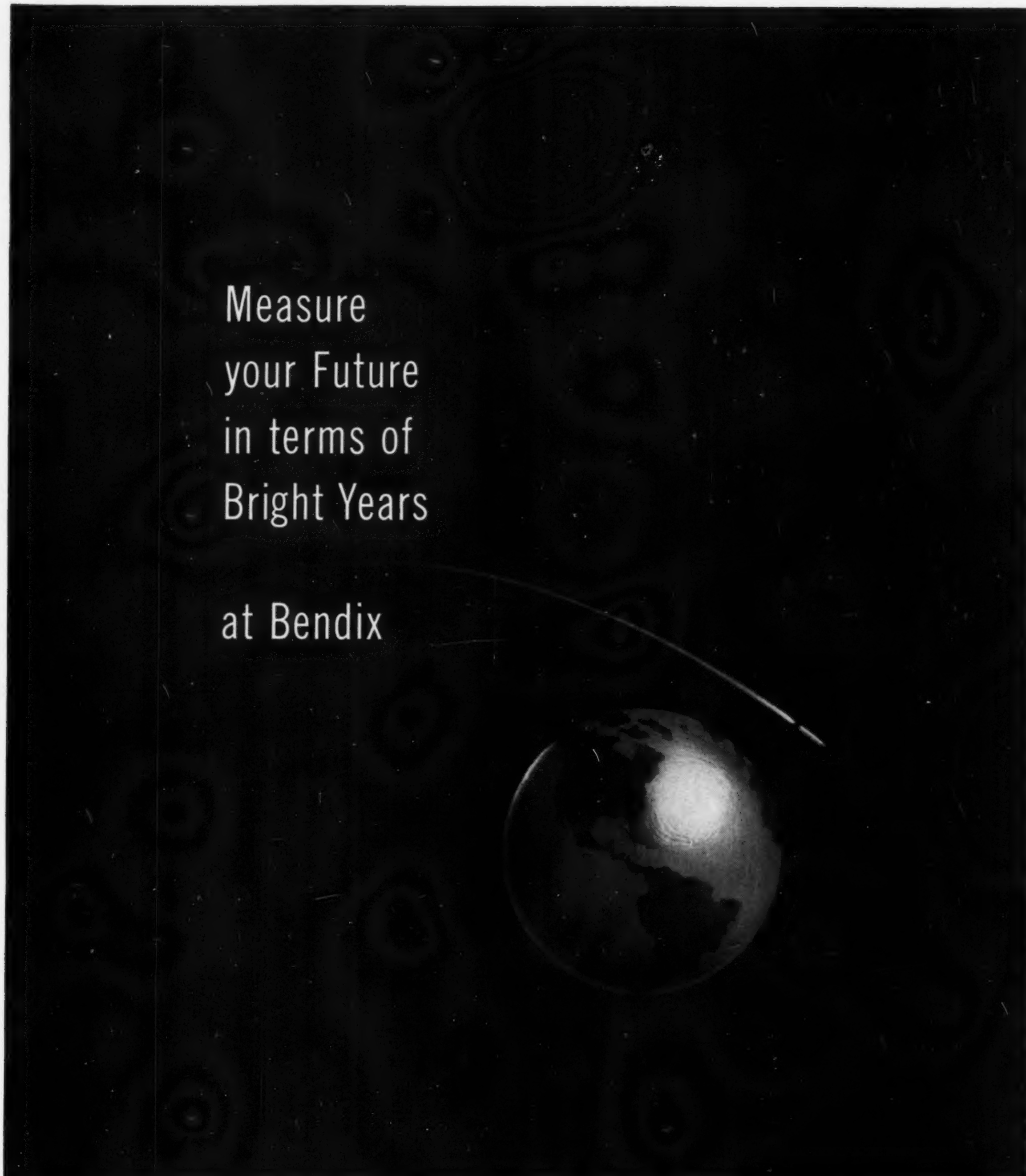
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JANUARY 1959 VOLUME 24 NO. 4

Cover: The two photographs on our cover are tipoffs to what lies inside. The upper photo shows the center of operations for the atomic-electric generating station at Shippingport, Pennsylvania. To read about what is being controlled here, see page 13. Below is a model of the *N. S. Savannah*. The free world's first nuclear-powered surface ship is discussed on page 22.

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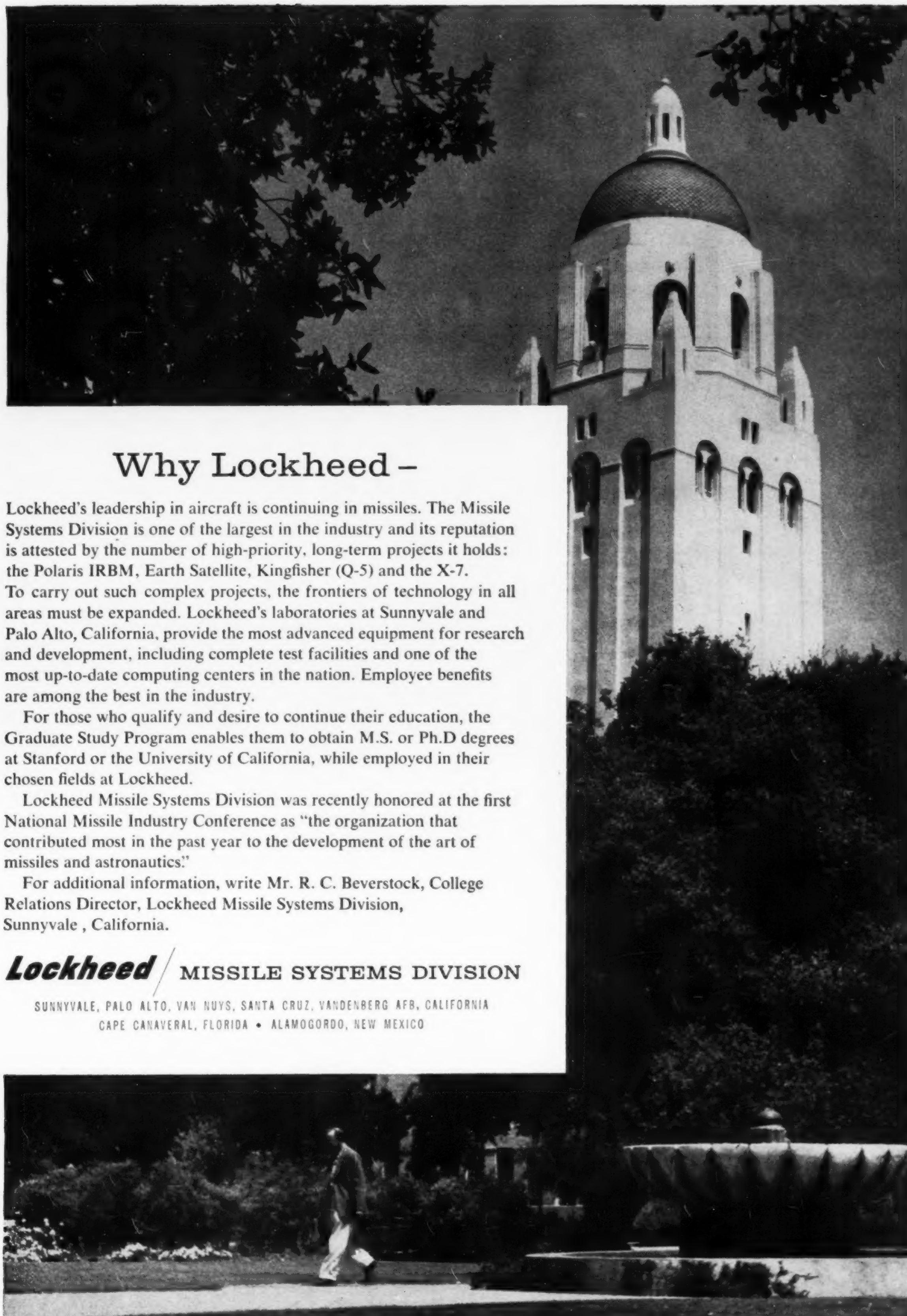
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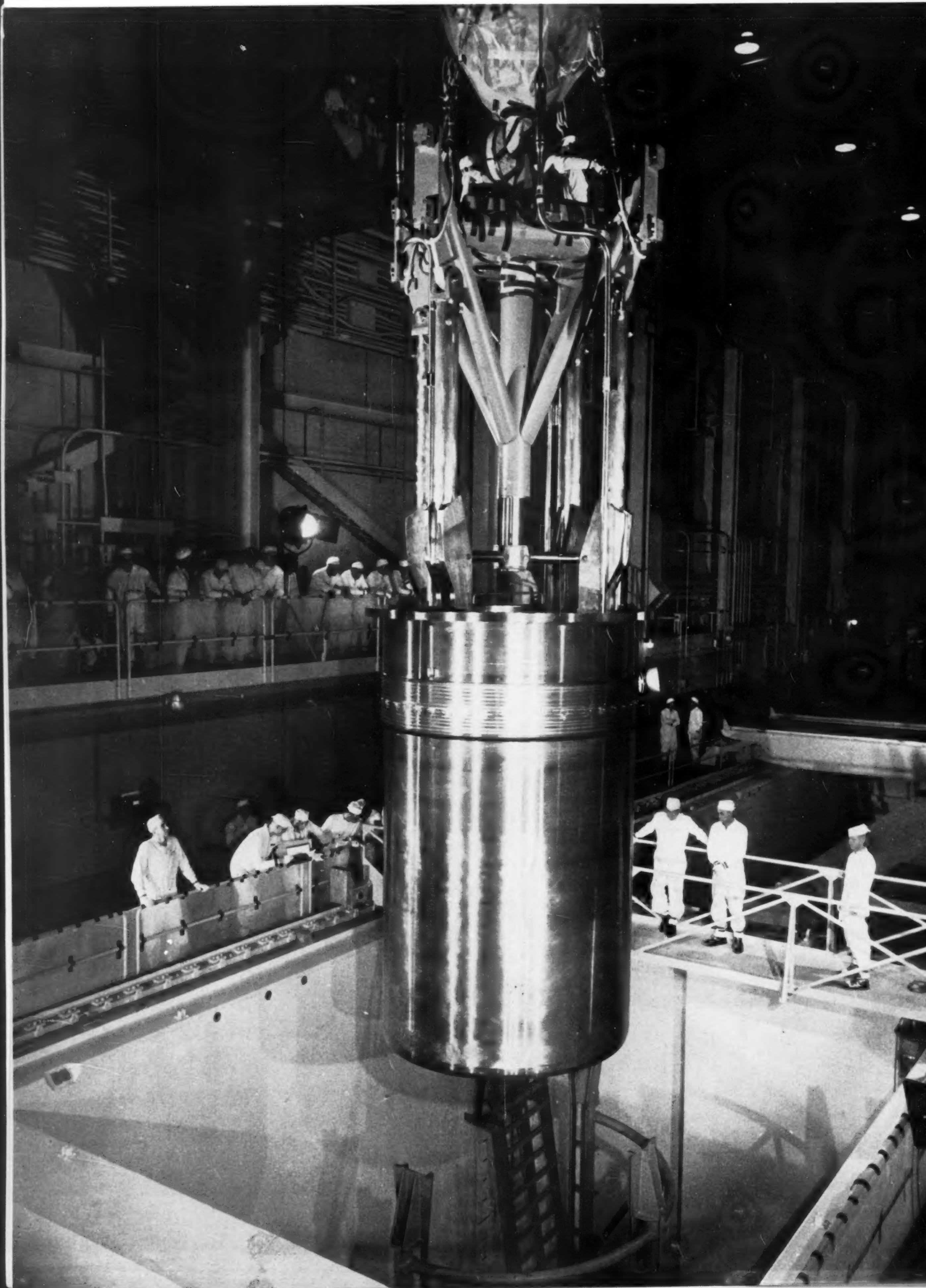

SHIPPINGPORT . . .

FULL SCALE SCIENTIFIC STUDY

by Roy J. Lamm, ChemE '61

On December 2, 1957, exactly fifteen years after the first nuclear chain reaction was produced by man, critical, nuclear operation of the pressurized water reactor at Shippingport Atomic Power Station began. Three weeks later 60,000 kilowatts of electricity flowed from the station into the vast distribution network of Duquesne Light Company supplying metropolitan Pittsburgh. This historic event marked the *first* successful operation of a large scale nuclear electric power plant in this country.

Built jointly by the Westinghouse Electric Corporation and the Duquesne Light Company under the Atomic Energy Commission's Civilian Power Reactor Program, the station cost 121 million dollars. While the Shippingport facility at this moment is producing much needed electricity, it has, to some extent during its construction and to a much greater extent after its completion, been providing important scientific data and technological know-how—know-how so vitally needed as more atomic power plants are built. This, in fact, was the primary consideration in the construction of the station, for now at Shippingport scientists and engineers at last have a full scale plant in which to study and obtain experimental data and operating experience that will aid in the design of future plants.

←

This is the heart of the nation's first full-scale atomic-electric generating station—the 58 ton, multimillion dollar nuclear core, or fuel charge. Within this core the "hot" nuclear reaction, or fission process, takes place when the Shipppingport atomic power plant is in operation. The nuclear furnace heats high-pressure water which then turns a second supply of water into steam, steam which turns a turboalternator to produce electricity.

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Basic Concepts of the PWR System

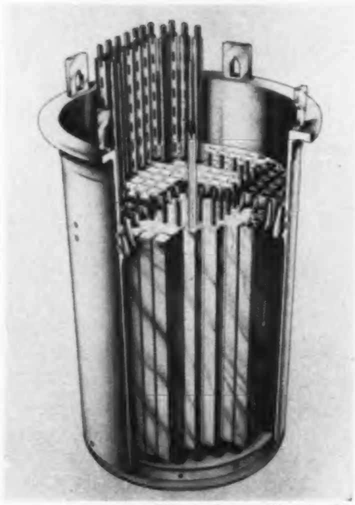
Until the day when direct conversion of nuclear energy to electrical energy becomes a reality, nuclear power plants must use the indirect, but economically feasible method of changing nuclear energy, to thermal energy, to mechanical energy and finally to electrical energy. In an ordinary steam generating station the thermal energy from the steam is converted into mechanical energy in a turbine and the mechanical energy in the turbine is changed into electrical energy in the generator. At Shippingport, too, the energy cycle from steam to electricity is employed. The primary difference between an atomic power station and a conventional station, however, is the source of heat which produces the steam. Whereas in the latter coal or sometimes oil is used to furnish thermal energy with which to manufacture steam, the former relies on a nuclear reaction to release fast neutrons which will collide with, and subsequently give up energy to, water molecules. The energized water molecules then change to steam. The heart of the Shippingport Station, then, is the nuclear reactor, producer of the neutrons.

At present there are several types of nuclear reactors based on radically different designs and theories. The pressurized water reactor (PWR) is by far the most advanced. For this reason the PWR system, the same one used in the famous nuclear submarine *Nautilus*, was chosen for Shippingport.

The basic network of such a system is schematically represented in figure one. The system consists of two loops—the primary, containing the nuclear reactor and heated water under pressure and the secondary where steam is actually produced.

Water is pumped through the primary loop into the reactor. Here fast neutrons given off from the nuclear reaction collide and transfer their energy to water molecules. The heated water under a very high pressure remains in the liquid state and is pumped to a heat exchanger where it gives up its energy to water in the secondary loop. The water in this second loop is not under high pressure and therefore turns into steam. After being dried, the steam is sent to a regular steam turbine.

The advantages of this PWR system are numerous. The primary loop and the water in it are physically separated from the secondary loop. Thus, if by a remote chance the water in the primary loop became contaminated with radioactive particles, it would be confined there and not allowed to spread radioactivity into the turbine and the unshielded portion of the station. Because the water in the primary loop is isolated, it can be purified to a high degree. Such very pure water reduces the possibility of corrosion of the cladding around the radioactive fuel elements. The liquid water in the reactor, obtained by putting the entire primary loop under high pressure, acts as an excellent moderator to the neutrons released in the nuclear reaction. If the system were not pressurized, the water would soon turn to steam, a poor moderator of neutrons. Without a good moderator an insufficient number of fast neutrons released in the nuclear fission would collide with water molecules. This would reduce the number of thermal neutrons (neutrons slowed by collision) which are available to continue the fission of the U–235 fuel.



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Cutaway of the pressure vessel shows the reactor core. The core is composed of 113 "blanket" fuel elements, containing 14 tons of natural uranium, surrounding 32 "seed" elements, containing 165 pounds of highly enriched uranium.

One of the most important assets of the PWR system is its negative temperature coefficient of reactivity. With this coefficient the reactor inherently tends to maintain the power level it was set at. If for some reason the temperature of the water entering the reactor suddenly drops, the power output automatically increases; and vice versa if the temperature of the inlet water increases, the power output decreases. Thus, because of the negative coefficient, the proper power level can be maintained with a minimum of outside control.

The Reactor

The reactor is the heart of the PWR system. The reactor pressure vessel, which is thirty-three feet high, nine feet in diameter, made of carbon steel plates and lined with one-quarter inch stainless steel, contains the nuclear core. The core (cross section shown in figure two) is composed of one hundred forty-five fuel assemblies—thirty-two of the "seed" type and one hundred thirteen of the "blanket" type. Each fuel assembly is seventy inches long and has a cross-section of five and one-half square inches. The seed assemblies or plates in the core are enriched uranium 235 protected from the hot water with a cladding of zirconium alloy. The blanket assemblies or rods are hollow zirconium alloy tubes filled with natural uranium oxide (UO_2) pellets. These fuel assemblies, when in their proper positions in the reactor, take the form of a cylinder six feet in diameter and six feet high.

The top of the reactor is the vessel head which contains the mechanism for the control rods. The control rods, thirty-two in all, are hafnium and can be inserted or withdrawn by remote control from the reactor core to change the power level or stop the reactor completely. At any given stage of core life these control rods will have a specific operating position. At this operating position whatever power output established for the reactor will be maintained by the rods. The chain reaction will just be sustained with the right number of neutrons for the heat level desired.

Seed and Blanket Concept

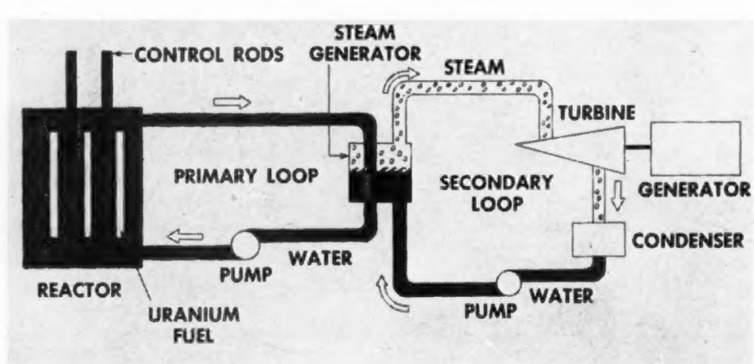
The seed and blanket arrangement of fuel assemblies in the core embodies an important concept worth further analysis. The seed elements containing the concentrated U–235, not only make continuance of the nuclear chain reaction possible, but also are copious sources of neutrons for power production. Conversely, the natural uranium blanket elements have only one part in 140 of U–235, the remainder being naturally occuring U–238. This natural U–238 is not fissionable by thermal neutrons as is U–235. Rather, it absorbs neutrons given off by fissioning U–235 to such an extent that it alone cannot sustain a nuclear chain reaction. Were this all that occurred, the seed and blanket system would hardly be advantageous.

However, another nuclear reaction does occur which adds a considerable quantity of energy to the system in addition to that given off by the U–235. When the U–238 absorbs neutrons from the seed elements, it becomes U–239. This unstable isotope decays to neptunium and finally plutonium 239. Plutonium 239, like U–235, is a fuel suitable for fissioning with thermal neutrons. Thus a new, useful fuel is being produced simultaneously with the burn-up of existing fuel. For every ten U–235 atoms destroyed six plutonium 239 atoms are formed, giving a conversion ratio of 0.6. This conversion ratio could be lifted above one and a so-called "breeder" reactor would be created. However, in the breeder type reactor power production is much less effective than in the "converter" type reactor used at Shippingport.

Because of the breeding effect in the blanket elements, their life is over twice that of the seed elements of the core (8000 hours for the blanket as compared to 3000 hours for the seed portion of the core). At the start of the reactor core life, roughly half of the power comes from the blanket. As the seed "burns up" the U–235, its effectiveness as a heat producer decreases. Conversely, as time passes, because more fuel is being produced than is being burned up, the blanket contributes a greater fraction of the total power.

The Coolant Loop

The heated water in the reactor is, in itself, useless. There must, then, be a means to carry the water under pressure to a heat exchanger



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A schematic diagram shows the two-loop system employed at Shippingport. With this system, the primary loop, exposed to lethal radioactivity, is isolated from the rest of the plant.

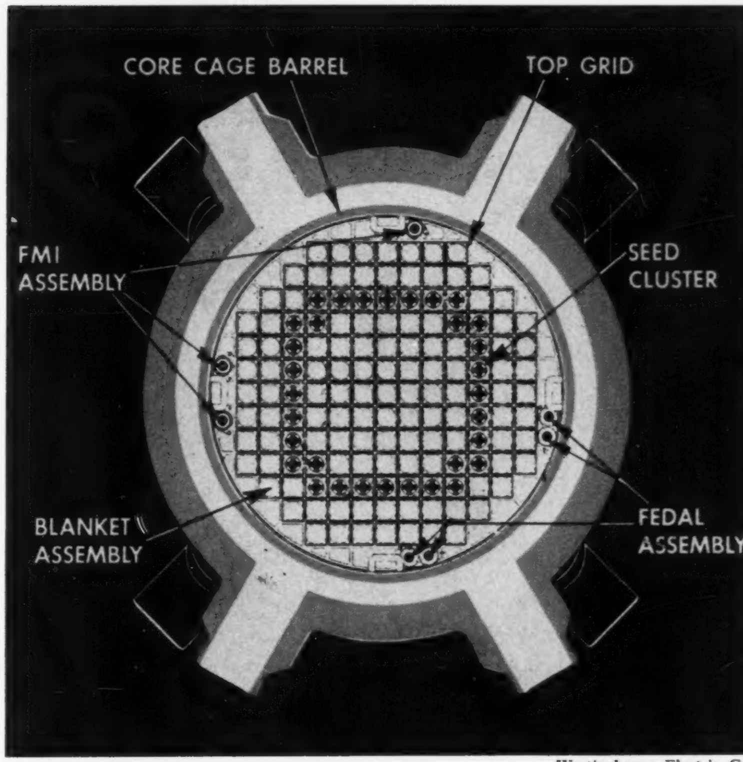
where it can give up its energy. The task is accomplished by four primary loops. Each is connected to the reactor and to its own heat exchanger and steam generator.

Two loops are connected to so-called U-shaped heat exchangers, while the other two have straight-through type heat exchangers. In the straight-through type the heated water from the top of the reactor which is at 538° F. and 2000 psia enters the stainless steel exchanger and flows through 2,096 tubes, each of which is thirty feet long and one-half inch in diameter.

In the "U" type exchanger the heated water from the top of the reactor under the same temperature and pressure flows through 921 three-quarter inch stainless steel tubes bent into a "U" shape. At the terminus of all the exchangers the water which returns to the bottom of the reactor is reduced in temperature to 508° F. The water surrounding the tubes in all the heat exchangers is immediately converted to steam at 600 psia, pumped to a steam drum where it is dried and then sent to the turbine. The turbine is an 1,800 rpm unit rated at 100,000 kilowatts. It handles 860,000 pounds of steam per hour, with a gross power output of 68,000 kilowatts. The station uses 8,000 kilowatts to operate, leaving a net output of 60,000 kilowatts.

Since it is vital to the safe operation of the station that boiling does not occur in the reactor or primary loop, a fool proof system for maintaining the pressure as close to 2,000 psia as possible is necessary. The system designed to perform this task is surprisingly simple, yet, highly reliable. Its main component is a pressurizing tank. This tank is tied into the primary system between the reactor and the steam generator.

During operation the tank has only 100 cubic feet of its 260 cubic foot volume filled with water. Submerged in this water are electric immersion heaters which supply heat to maintain a 2,000 psia steam head in the tank. If, for example, the pressure in the reactor system should suddenly drop the pressure in the tank would also drop quite quickly. This would immediately cause some of the water in the tank to flash into steam. The extra steam would increase the pressure in the



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A cross-section of the nuclear reactor core shows the arrangement of the 113 "blanket" fuel elements around the 32 "seed" elements.

tank and thus out in the primary system as well. If the pressure in the primary system suddenly rose, a spray nozzle in the top of the tank would spray cooled water into the tank, condensing some of the steam, and thereby lowering the system pressure back to normal.

Safety Precautions

Many new dangers to human safety have been encountered in the Shippingport project. For this reason the design and construction of the station has had to meet elaborate, stringent safety requirements. No expense or trouble has been spared to insure the personnel in the station and the public in the surrounding area against hazard. A secondary consideration in the installation of the many safety devices is the operational data that will be obtained for use in designing future safety systems in atomic power plants.

Probably the most feared danger by the public is the possibility of a nuclear explosion similar to that of an A-bomb. Such an occurrence with the PWR reactor is impossible. The very worst "runaway" nuclear reactivity accident that could occur would only result in the melting of the cladding on the fuel elements in the core with subsequent release of radioactive particles into the primary loop. If this did occur, there would still be two of three barriers left between the contaminated particles and the outside. The first barrier between radioactivity and personnel is the zirconium alloy cladding on the fuel elements. The second barrier is the all welded sealed primary loop, and the third is the plant container, a group of interconnected, vapor tight, steel pressure vessels.

In addition to the safety offered by these three barriers many other measures have been taken, because of the designers' assumption that no single safety system is failure-proof. All conceivable accidents that might occur in the PWR plant have been analyzed.

To give all the conclusions of this accident study would be impossible here, but consideration of two of the most serious accidents that

(Continued on Page 25)

Eli Whitney was the first practitioner of quality control. By applying the principles of mass production and interchangeable parts, both of which are based on quality control, he was able to build the then unheard of quantity of 10,000 muskets for the government.

by

David Lamensdorf,

EE '60

WHY QUALITY CONTROL?

People are not perfect. Plans created by people are not perfect. Machines built by people are not perfect. Therein lies the essential justification of quality control engineering.

Quality control engineering is a relatively new field organized for the purpose of creating a balanced compromise between cost, performance, endurance, and production time with respect to a manufactured product or service.

What is Quality Control?

Quality is not meant to imply "best" in the absolute sense, but rather best for certain customer conditions. The product must meet the needs of the customer within the time allowed, using the most economical methods feasible under the conditions. Therefore, the best product in a physical sense is not necessarily the best "quality-wise."

Control involves the use of past experience to predict how a product's characteristics may be expected to vary within the desired limits in the future. Prediction within limits means it is possible to state approximately the probability that the measured characteristic will fall within the given limits. The prediction must take into consideration all of the unknown factors present in the particular characteristic being measured. By having an adequate system of controls, a manufacturer is able to reduce the cost of inspection and, the number of rejections and to attain the maximum benefit from quantity production through these reductions. A secondary advantage of control is the possibility of reducing the tolerance limits of a characteristic without any great increase in expense.

How Did Quality Control Begin?

Eli Whitney, famed for his invention of the cotton gin, was the first practitioner of the principles of

quality control. In 1797, he accepted a contract from the United States government to build the then unheard of quantity of 10,000 muskets within two years. It was "unheard of" because all of the government arms-makers, using the normal eighteenth century handicraft methods of one man on a musket from start to finish, could not turn out that many muskets in several years. However, Whitney, applying the principles of mass production and interchangeable parts, both of which are based upon quality control, was able to accomplish this feat. His success was a direct result of his ability to control his machines, his material, and his manpower.

For the next century, with the industrial era just in its infancy, the ideas of quality control did not make any further great strides. Quality was mostly in the hands of the workers and foremen. It consisted at most of inspection and possibly testing of the manufactured product. With increasing mechanization, responsibility for quality broadened to inspectors who became independent of the foremen.

In time responsibility was even further spread. Here is a good approximation of the organization in most large companies today. The engineering department specifies the quality; the laboratory sets the standards; production and manufacturing is responsible for making the quality product; planning and methods sets up the procedures and facilities necessary; and the inspection and test department passes on the final conformance of the product.

In the twenties, Dr. Walter A. Shewhart, of the Bell Laboratories, often called the father of modern quality control, published several papers in which he conceived and developed the theory of statistical quality control. His methods were not accepted throughout the country though, until 1940, when they were promoted by the government among national defense contractors. They then spread rapidly and were in common use by the end of the war.

What Is Statistical Q-C?

Statistical quality control is based on the concept that the output of a manufacturing process is not identical units but individual items whose characteristics are essentially similar in their degrees of variation, one from the other, with respect to their ability to meet a given set of specifications. Variation of these characteristics within certain limits is inevitable and acceptable. Variation outside of these limits should be discovered and corrected either in the design or the manufacturing process. The discovery and correction should be accomplished through the use of the various tools of statistical quality control, such as control charts and sampling procedures. These tools were first suggested by Shewhart and have since been developed and refined by many of the people who have come to work in quality control.

A control chart is basically a graph of the measurement of a certain product characteristic versus the number of products inspected. There are many variations to fit various applications. Through observation of this chart, it can be determined whether or not a process is in control, and if not what corrections need to be made to bring it under control.

Sampling inspection is based on the theory that if one or two of a particular "lot" of units does not meet a set specification, then it is probable that many of the others in that lot will also fail to meet this specification. This flaw can therefore be detected by a "sampling inspection" of a few units in each lot. Sampling inspection is obviously only good for mass production where automatic or semiautomatic machines are used.

What Are Modern Q-C Problems?

The core of the approach to modern quality control is to control the product quality during the process of design and manufacture so as to prevent poor quality rather than to correct poor quality after the article has been produced. In other words, the ultimate aim is to control the process rather than the product. By controlling all of the processes, a quality product must result.

Today, quality control has become such a vital part of every manufacturing concern that it is set up as a completely autonomous engineering group. At the same time,

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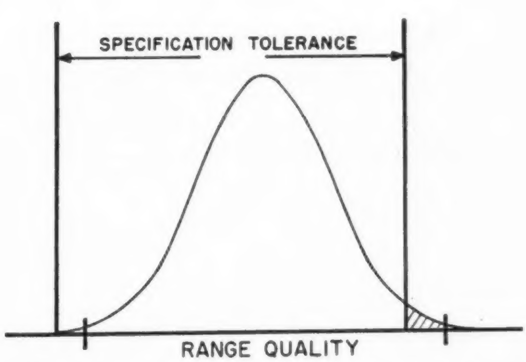
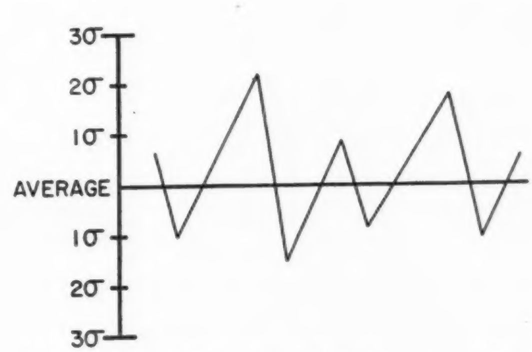


Distribution curve shows the relation between process capabilities and specified tolerance. The ordinate is the ratio of number of units to total number of units in lot. Most of the units produced by this process fall within the specified tolerance. A few which fall in the cross-hatched region, however, are beyond the tolerance limits and therefore must be rejected.



This typical control chart indicated whether a process is in "control". σ is the standard deviation of the distribution, and each peak represents a point in time when a unit or group of units of production was sampled. When a peak falls outside of the 3σ limit the process producing the units is considered out of control. It is then stopped and adjusted to bring the sample deviations within the 3σ limit.

METALLURGY AT THE DAWN OF HISTORY

by John M. Walsh III, ChemE '59

The early history of metallurgy is a story of probable happenings at indefinite times. Most of the events discussed here are hypotheses, each based on certain pieces of evidence: unearthed remains of ancient civilization, inscriptions in tombs, or fragmentary writings from some later generation. Other clues have come from studies of modern primitive societies whose cultures may parallel those of their predecessors, the original Metal Age man.

The history of metallurgy then, is a history of hypotheses, built on a substantial basis of factual clues, which may indicate how primitive man found the answers to the secrets of metal-working.

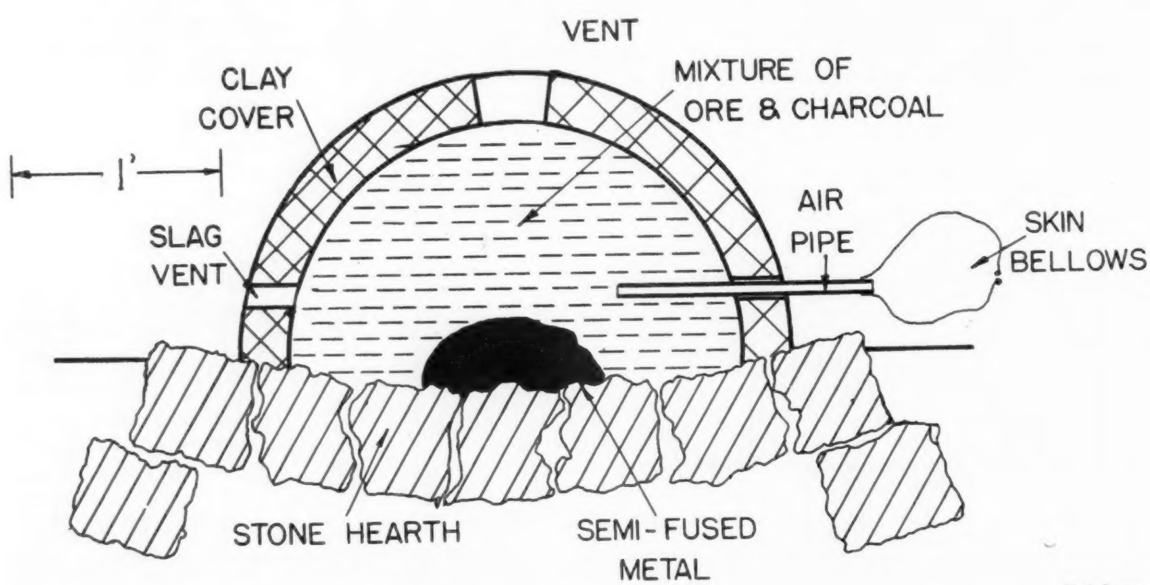
Before launching into a discussion of the chronology of metallurgy, we shall attempt to decide who discovered early metallurgical techniques. The study of modern aboriginal societies and prehistoric inscriptions discredits the possibility that the early metallurgist had a true "scientific mind." Even after he had mastered the task of smelting metal, he did not really know what a metal was. We should not attribute the concept of metal to even the Egyptians of 1200 B.C. The early smelters and workers of metal were artists, not scientists, and early metallurgical processes were discovered by accident and not by scientific endeavor.

Metals Found in Elemental State

Early man's first metals were the gold, copper, and silver nuggets that he found lying out in the open. Soon he realized that these peculiar stones could be shaped by beating, and metals were put to use.

Experts disagree about whether or not gold was used before copper. The metallurgy of gold is by far the simplest and provides a good starting point for a discussion of the techniques of metal-working. Deposits of gold were widespread throughout ancient civilizations, but only in Egypt were the deposits extensive. In early times Egypt essentially monopolized the production of gold.

Native gold is the most common form in which gold is found, and early refining methods were merely ways of separating the gold from the gangue, or unwanted foreign matter intermixed with the metal. The most common separation was effected by grinding the ore into dust-fine particles by hand and then washing the mixture on a table with a gentle stream of water. This carried away the gangue and



Ted Loane

One of the first crude furnaces for the refining of metals consisted only of a stone hearth with clay walls. Such early metal refining was an extremely simple process, for the ore was merely crushed, mixed with charcoal, and placed on the hearth for reduction.

left the heavier particles of gold. These particles were picked up on a damp sponge. In later times, the particles were then melted down in a crucible. The first mining operations were similar to gold washing, and are now called placer mining.

Native copper was probably the second metal to be used by ancient man. In early times, both native copper and gold were used mainly for making jewelry. Native copper was more plentiful than gold and was more often obtained in pieces of useable size. Early man obtained his copper by picking up small pieces on the ground, or by knocking protruding portions from copper boulders with stone axes. As copper became more readily accessible to him, primitive man began to use it for fabricating useful implements. Some of these implements have been found in Chaldean graves of 4500 B.C.

Long after copper and gold were in use, silver was acquired by primitive man. Called "white gold," native silver nuggets were picked up on or just below the surface of the ground. Primitive man hammered nuggets of native silver both to shape them and remove the tarnish. Silver ornaments are known to have been in existence as early as 3000 B.C.

The other metal used by early man was called electrum. It was actually an alloy of gold and silver and probably occurred naturally in lands near Egypt. Because electrum is an alloy, it is harder than gold and thus in one way superior to gold for making jewelry.

This, then, was the status of the metal-working craft before fire entered the picture. Metallic gold, copper, and silver were known to man. He could mine them, separate the metal from the gangue, and work the metal into useful shapes. He had no concept of metal as a separate class of substances but considered it a peculiar type of stone, which could be shaped by beating but not by chipping. In appearance, metal-working was just one part of the stone-working craft.

Use of Fire a Major Discovery

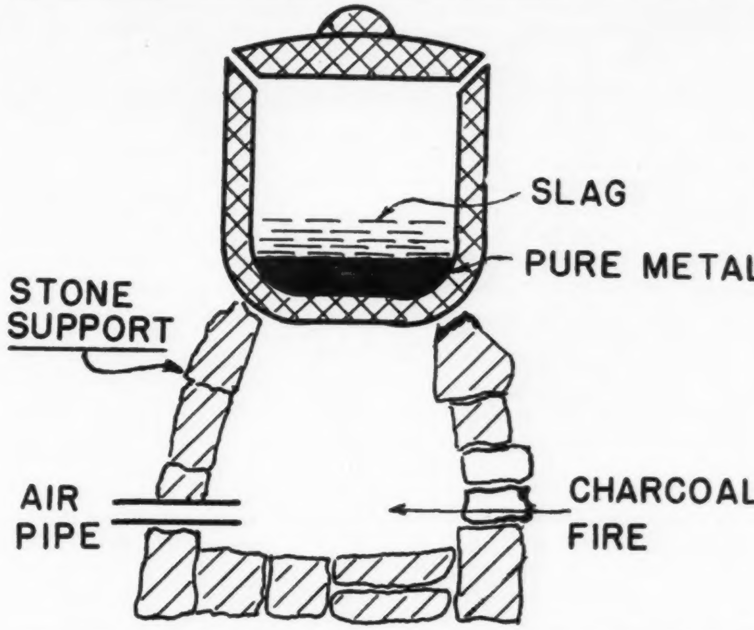
The use of fire in the processing of metal was probably the most important discovery in the history of this craft. For centuries, early man had known how to shape pieces of metal by beating, bending, and cutting them. As time went on, he came to realize that working metal hardened it. Although this made stronger weapons, it made metal-working much more difficult. Around 4200 B.C. the process of using fire to soften and anneal metal was stumbled across. This technique gave ancient man a little control over the properties of the object he was working.

In the middle of the fourth millenium B.C., the process of casting was discovered when the primitive smith came to realize that the liquid metal, when cooled, would retain the shape it had when fluid. The first casting was done with crude sand or clay molds, which later were developed into molds sculptured in rocks. The discovery of casting lessened the need for forging and annealing, greatly shortened the amount of time spent to make any metallic implement, and increased the number of shapes which could be made from metal. In any case it was still the nature of the metal or alloy which determined the properties of the finished product, not the treatment it received.

The "Age of Metals" began around 3500 B.C. when the smelting of ores became known to ancient man. Before this time, metal had been a rarity to be collected wherever it could be found. Now man had at his disposal a method of producing metal from far more common substances. To be sure, metal was still far from plentiful, but with time it would become less and less of a novelty.

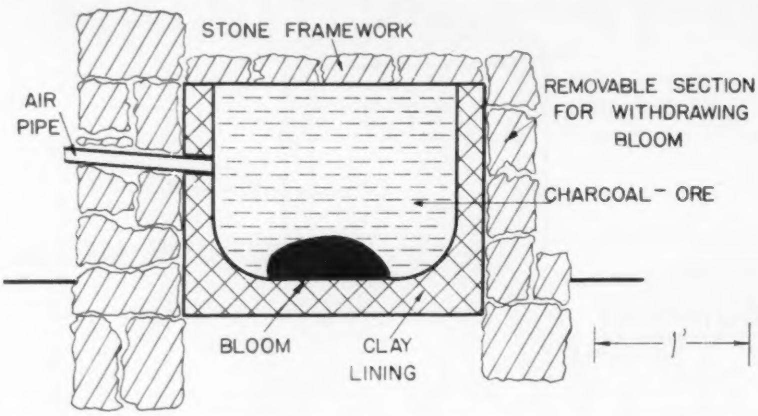
The discovery of smelting was the result of an accident. Theories of its origin range from the ignition of an oil seepage in contact with copper ore to an Egyptian lady dropping some copper cosmetic into a brazier. It must be remembered that the ancient mind learned very slowly, and whatever accident caused the discovery must have occurred many times before it made a lasting impression on the observer.

Both classical tradition and archaeological studies indicate that smelting originated in Northern Persia and was soon passed on to the Near East. In light of the tools and implements used in prehistoric metallurgy, it seems likely that metallurgy originated at one center but that each new metallurgical



Robert Franson

In order to cast and purify the metal after its initial reduction, it was placed in a crucible and heated. Early man was very slow in developing metal technology, for it did not occur to him to take the next logical step of building the crucible he used into the hearth of the furnace.



Ted Loane

center developed its own processes and techniques.

As would be expected, early metal refining was an extremely simple and crude process. The ore was crushed and hand picked prior to smelting. The broken ore was mixed with charcoal and the mixture was placed in a pit on the side of a hill and ignited. After smelting was finished, the unconsumed fuel was removed to allow the metal to cool. When the metal had just solidified and was still brittle, it was broken up with a hammer. The metal produced was spongy, incompletely fused, and full of extraneous matter. This undesired matter was removed by beating.

Some authorities belive that the campfire may have been the first metallurgical hearth. If so, it was soon improved by digging a hole to collect the metal, lining the hole with clay to keep the metal clean, and enclosing the hole in the floor with stones, thus producing the first crude furnace. Later, to conserve heat, the top of the furnace was curved in and air admitted through holes in the bottom of the hearth. The molten metal was removed through other holes. The shaft furnace originated near the end of the Bronze Age, when stone walls were erected around the hearth to form a chimney. Undoubtedly, the creation of metallurgical furnaces was greatly influenced by previously existing pottery kilns and furnaces. In casting and purifying, the metal was kept separate from the fuel by heating it in a crucible. Although it would seem a logical step to build the crucible into the hearth of the furnace, this never took place.

Learning that his fires burned better when in a breeze, the primitive metallurgist built his furnaces on the windward side or top of a hill and with chimneys to conduct a draught through his smelting fire. The Egyptians used blowpipes to create draught as early as 2500 B.C. These tuyeres were metal pipes with clay nozzles. The Sumerians and Babylonians used hollow reeds to increase the flow of air to the fire. The bellows was later invented and appeared in Egypt around 1500 B.C. The early bellows was an animal skin with a pipe attached to one leg; a later form was a rigid dish covered with a skin diaphragm.

Alloys Formed from Mixed Ores

Few metals produced in antiquity were purified to any degree. Ores were commonly found mixed, and, in many cases, the alloys produced were as important as pure metals.

Bronze is thought to have been the most important early alloy. It was probably discovered when naturally mixed ores containing copper and an appreciable percentage of tin were smelted. If this smelting of naturally mixed ores had occurred many times, primitive man could have come to associate the properties of bronze with the mixtures of the ores. Later he probably mixed tin ores with copper before smelting to obtain an alloy with the desired properties. In time he may have tried smelting the tin ore alone and thus have discovered tin. The last hypothesis is supported by the fact that bronze was known to primitive man long before he knew of tin.

The reasons for using tin in copper cast implements were twofold. Although the melting point of the bronze was not noticeably lower than that of copper, the melt was more liquid, and the solid was harder and less porous. These factors made it possible to cast more durable products of a wider variety of shapes than before.

Many ancient bronzes contain a considerable portion of arsenic, but in most cases this mixing appears to be unintentional. It is certain that any zinc included in preclassical bronze was accidental because the ancients had no knowledge of this metal. Antimony also appears in the bronzes, and the first inclusion of this metal may also have been accidental although it was known to the ancients and later deliberately added to bronzes.

Brass was produced as early as the sixth century B.C. but, like the first bronze, its production was a purely empirical process with metallic zinc never entering the picture. Primitive metallurgists could not have known the delicate process of reducing zinc ores with finely divided charcoal and the subsequent condensing of zinc vapors produced. In the early production of brass, zinc ore (calmia) mixed with charcoal was covered with metallic copper which melted when the charcoal was ignited. The brass was a highly desirable alloy because it resembled gold.

As new metals were developed, new techniques for handling these metals evolved and old techniques were altered. Casting was much improved by the use of bronze which could be cast with much greater facility than most other metals. The main use of bronze was for making statuettes which were at first cast solid and later, when the technique was evolved, were cast hollow using a center of sand

Larger and more refined furnaces, like the Corsican Furnace (upper left) and the Indian Crucible Furnace (lower right) developed after the discovery of iron. The smelting and steeling of this new metal demanded a metal technology based on the new principle that a metal's properties were a function mainly of its treatment. In order to master this new technology, new and better tools *had* to be developed.

and beeswax coated with clay. Later the technique of shell casting (filling the mold with molten bronze, and after a hardened skin had formed, pouring the molten center out) was used to save both time and metal.

New methods of joining and plating metallic and non-metallic objects were devised. In some isolated cases, archeologists have found items which were soldered by craftsmen in the days of the Old Kingdom of Egypt. The technique used was that of hard soldering (soldering with silver). Most objects were joined by riveting or by fitting them closely and hammering. Plating of objects with thin sheets of metal was common and was accomplished by nailing the thin sheets of gold or silver to the plated object.

Within 1,000 years of the discovery of smelting, simple processes had evolved to extract and shape gold, silver, copper, bronze, lead, antimony and tin. However, while the advent of metal-working and metal implements made innumerable new achievements possible, there was no great change-over from the use of stone to the use of metal. The known deposits of ore were scarce, and the manufacture of the implements of war utilized most of these deposits. The nobles and priests took a large portion of what was left.

The common man had little metal from which to make axes and knives. In most cases flint was still retained to make the rougher objects. In fact Herodotus writes that Xerxes' soldiers were partially armed with stone weapons when they invaded Greece. The change from the Age of Stone to the Age of Metal was slow and resulted in early man's having metal for special purposes, not for common use.

Iron is Most Important Discovery

Of all the metals, iron is the most useful. It is plentiful and its production, once mastered, presented no great difficulty to the primitive metallurgist. If the refining of other metals was known around 3500 B.C., how is it that iron smelting was not discovered by man until two milleniums later?

Although it is true that iron can be reduced to metal at lower temperatures than copper, the iron does not fully melt at these temperatures. The metal formed is not recognizable unless beaten to remove the slag and cinders. Also delaying the discovery of iron was the fact that ores rarely occur in the presence of those other metals known to early man. This made it unlikely that iron would be discovered while smelting the ore of another metal. A third delaying factor is that only under exceptional circumstances does metallic iron occur in the presence of iron ore.

One of the most disputed dates in history is that of the first smelting of iron. Although a few early iron implements have been found, the scarcity of these finds is evidence against the early general use of iron. Some have taken the writings of Herodotus and the finding of a piece of iron in the pyramid at Giza as evidence that the pyramid builders were users of iron. Neither of these pieces of evidence has been fully authenticated.

Man-made iron occurred in Mesopotamia as early as 2500 B.C., but the metal was probably produced in small amounts as the by-product of the smelting of other metals. During the period of 1900 B.C. to 1400 B.C. the use of iron in ornaments and ceremonial weapons became more common. However, the suspicion with which people regarded this metal indicates that its production was neither well understood nor common practice.

The production of "steeled" wrought iron was first grasped by the Chalybes who had a monopoly on its production for 200 years until 1200 B.C. By this time the knowledge of "steeled" iron and its production had gradually spread throughout the Near East. Iron was still being produced only in small quantities. The greatest spread of iron-working came with the downfall of the Hittite empire. Many of the iron-working tribes were driven to other regions. Previous unsuccessful attempts to smelt iron in the new homes of the iron-working tribes paved the way for the technology of this new people. The steel produced was superior to bronze, and its technology spread rapidly through Asia Minor and the Mediterranean between 1200 B.C. and 1000 B.C.

The smelting and steeling of iron produced a metal technology based on the new principle of the metal's properties being due mainly to its treatment and not its alloy composition. In order to master the production of iron, new techniques and tools had to be developed. First, the correct type and amount of flux had to be used to remove various types of gangue. Secondly, to remove the slag from the bloom (mixed slag and reduced metal), the bloom had to be reheated and beaten. This required special furnaces and new hammers and tongs to handle the heavy masses.

After the wrought iron was produced, it had to be converted to steel. This required the new processes of carburization, quenching, and tempering which were developed in that order. The carbon content of the steel determines the hardness it can attain under proper treatment. The wrought iron produced by the early metallurgists contained essentially no carbon and was too soft to be useful. Gradually it was learned that the hardenability of the metal would be improved if the iron were heated in the pres-

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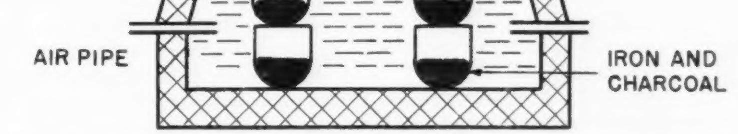

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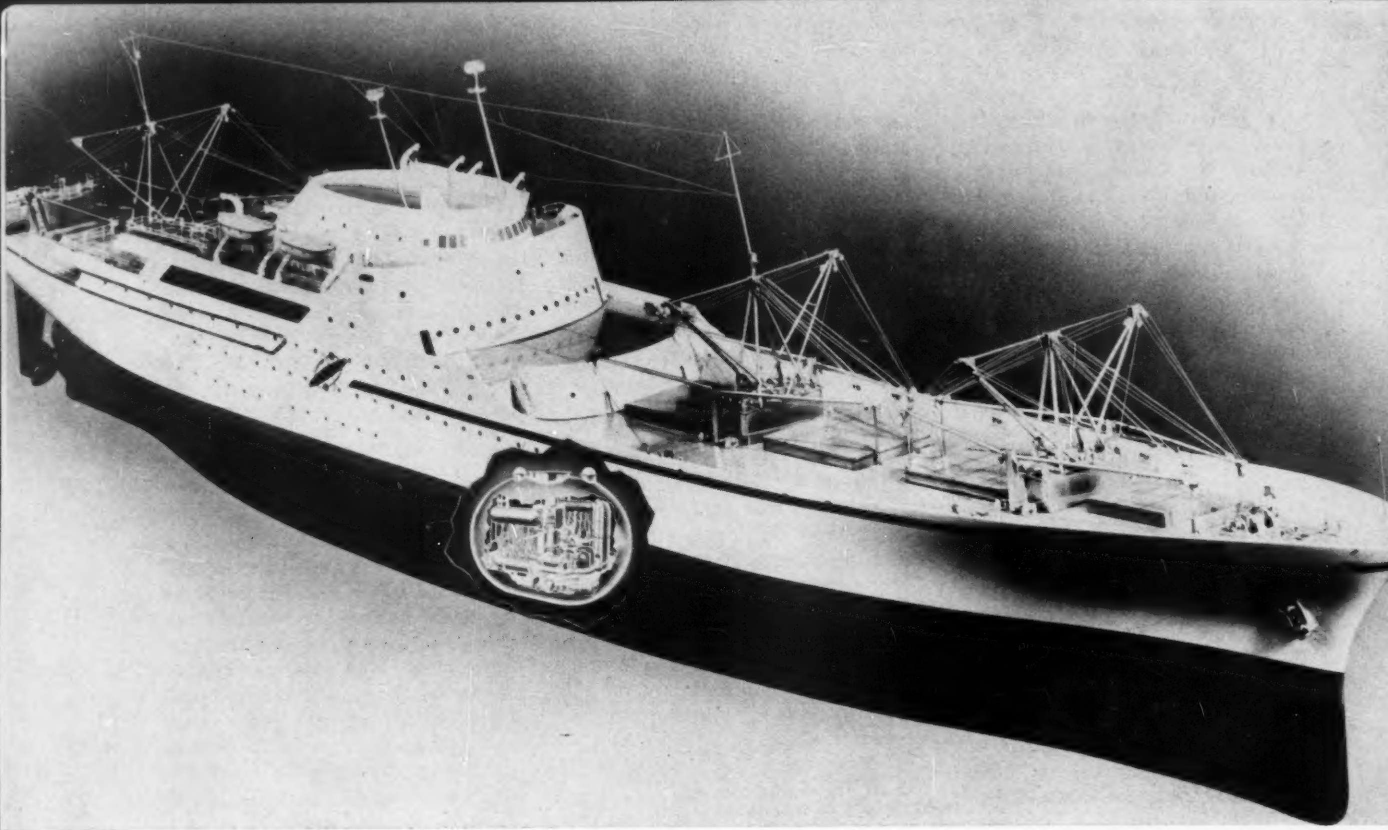


THE 'SAVANNAH' . . .
FIRST NUCLEAR SURFACE SHIP

by David Kessler, ME '62

"It was seventy-five years after the invention of steam power before the first steamship appeared, but in just twelve years after atomic power was unleashed, our first nuclear subs were operating." This surprising fact was stated recently by Rear Admiral Albert G. Mumma, chief of the Navy's Bureau of Ships.

The United States is presently launching nuclear vessels at a faster rate than any other nation. Since the successful debut of the *Nautilus,* the United States Navy has built or planned some twenty-two atomic submarines. Now the United States' first atomic surface vessel is in the offing. A merchant ship, the *N.S. Savannah,* is expected to enter service in the spring of 1960.

The ship is taking shape on the drawing boards of George C. Sharp, Inc., Naval Architects and in the shipyards of the New York Shipbuilding Corporation. The nuclear power plant is being supplied by the Babcock and Wilcox Company. The entire project is taking place through the combined efforts of the Maritime Administration and the Atomic Energy Commission.

A combination passenger-cargo ship, the *Savannah* is designed as a single screw vessel 587 feet in overall length. She is capable of a normal cruising speed of twenty-one knots, will be manned by a crew of 120, and will have accommodations for sixty passengers.

The atomic merchantman is a model of economy. Her reactor and propulsion systems are similar to those of the *Nautilus,* which has already traveled more than 200,000 miles. Unmarred by smokestacks, the *Savannah's* decks should appear neat and efficient.

There are three complete decks,

below which are cargo holds at various levels. The thirty passenger staterooms are located on the weather deck. The public rooms, including the main lounge, library, bar, dance area, and cocktail lounge are of a rather average status. A modest-sized swimming pool is located on the promenade deck. The passenger accommodations will be spacious and comfortable, reflecting a style of friendly living.

Among the ship's conveniences is a device for curbing seasickness. Stabilizing fins will hold the *Savannah's* roll to a minimum.* And for the convenience of the scientists and engineers who will be on-lookers during the merchantship's first year of operation—a test and trial period—there will be closed circuit television and an auditorium, both of which will be used for technical demonstrations and lectures.

According to Maritime Administrator Clarence G. Morse, the *Savannah* will have a threefold function. For one year it will be used for tests and trials. Following this period, a worldwide tour with demonstrations in other nations is likely. Another function will be its possible use as a commercial vessel under charter to a U.S. operator. However, citizens will not be permitted to book passage for three to five years after the termination of the trial period.

The Reactor System

The reactor system's main components consist of a reactor cooling system, which is referred to as the primary cooling system, and its auxiliaries which serve the primary system such as the pressurizer, intermediate cooling system, purification system, and the reactor control and instrumentation systems.

The pressurized water reactor system functions in the following manner: the primary water pumped through the system receives heat in the reactor as a result of controlled nuclear fission and gives up this heat in the steam generators. These generators are arranged in parallel and supply steam for the operation of the propulsion turbines and auxiliary turbine generators. The major portion of the reactor system is enclosed within a sealed and shielded containment vessel designed to contain the products of any rupture in the reactor system during operation. This containment vessel will be approximately fifty feet long and thirty-five feet in diameter.

The type of reactor core that will be used in the *Savannah* has a number of distinct advantages. The use of rods filled with UO_2 will provide an extremely rugged core which is less susceptible to distortion of flow channels and to burnout than in a plate type core. Secondly, because the oxide in the rods is almost completely inert to water, a defect in a fuel element will produce no serious chemical reaction making it necessary to shutdown. Thirdly, the UO_2 insures a greater fuel economy than a fully enriched reactor using metallic elements. This economy results from both the long life and the small production of excess plutonium in such a core.

By using a large, long-life core, another distinct advantage results. The average neutron flux and corresponding maximum surface temperature in the core can be held down, insuring better core operating conditions and reliability. Finally, the potential of this type of core offers opportunities for further economy.

Twenty-one control rods will regulate the excess reactivity of the reactor. Twenty shim rods designed to control reactivity losses due to burnout of fuel, buildup of poisons and higher isotopes, and designed to compensate for larger short-time reactivity changes such as transient xenon poisoning will be in operation.

The Propulsion System

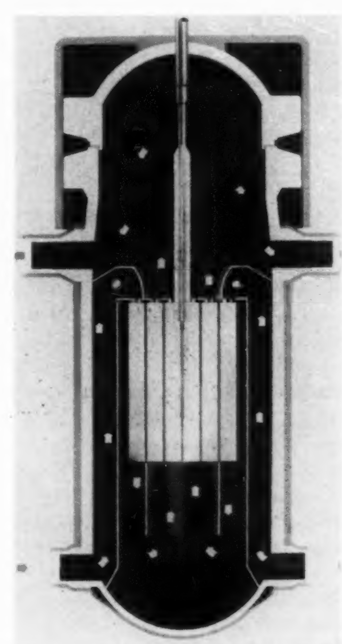
The other principal element comprising the power plant is the propulsion system consisting of a geared steam turbine unit which drives a single propeller. The cooling water of the nuclear reactor heats two main steam generators that supply the turbine unit with steam. The auxiliary electric power and steam requirements are normally provided by two geared steam turbine generator sets and one low pressure steam generator. These units are also supplied with steam from the main steam generators. The standby electric and steam requirements are furnished by two diesel powered generator sets and one oil fired package boiler. Emergency power is furnished by a diesel powered emergency generator. Also, a 750-horsepower "take-home" propulsion motor, powered by the standby diesel generators, furnishes emergency propulsion power.

The thermal efficiency of the atomic merchantship is comparable to that of a conventional ship of the same power and type. The disadvantage of the low steam conditions is offset by the efficiency of the reactor steam generator compared with that of a conventional oil-fired boiler.

Safety Stressed

The principal problems introduced in the design and construction of a nuclear propelled vessel are those involving safety. The safety of the ship, of the personnel aboard, and of the community is the foremost consideration of the designers. The safety features that are now being planned are still in the experimental stage and therefore may still be changed or reorganized.

Containment: The possible re-



Babcock & Wilcox

In the *Savannah's* pressurized water-cooled reactor, primary water enters the reactor vessel through the two lower nozzles, passes through the annuli between the thermal shields, then through the outer fuel elements of the core, and upward through the center of the core, leaving through the upper nozzles.

* See *Cornell Engineer*, October, 1958.

lease of fission products in case of an accident to the primary reactor system is one of the fundamental safety problems of a pressurized water cooled reactor plant. After the effects of such an accident and the possible safety measures to counteract an accident had been considered, it was decided to install the reactor, coolant systems, main steam generators, and associated auxiliaries within a shielded pressure vessel. This vessel would be capable of retaining the mechanical energy as well as the radiation energy resulting from an accident. However, a containment vessel may not be necessary in the future after the reliability of the ship's reactor has been tested.

For this ship, the containment vessel is designed as a cylindrical section with hemispherical ends. The underlying containment philosophy provides that the containment vessel should be located where it can be least severely damaged in the event of a collision.

Radiation and Shielding: The primary shielding about the reactor vessel is constructed to allow maintenance personnel to enter the vessel within two hours after the reactor has been shut down. Secondary shielding is necessary to envelop the containment vessel and maintain the intensity of radiation at safe levels both under normal conditions and during leakage of the primary system water into the containment vessel.

Operational Flexibility: The nuclear ship is designed to perform like conventional ships. It will have similar maneuvering abilities. Its power plant is designed so that the need for complete shutdown is held to a minimum. Shutdown would occur only for dire reasons, tolerable to the same degree as overspeed shutdown on a single screw electric drive ship.

The usual emergency generator, which provides power for essential services in the event electric power from the engine room fails, will be located on an upper deck. The emergency generator will also provide power for the reactor cooling pump, which facilitates the removal of decay heat.

Monitoring and Waste Disposal: The *Savannah* will be outfitted with both a radiation monitoring system and a small physics lab, which will be located next to the hospital area. In addition, a decontamination area is provided in the reactor compartment.

The usual problem of waste disposal will be solved by removal of radioactive waste every fifty days in home port. Air from the voids around the containment vessel will be continuously exhausted by a high vacuum fan and will be discharged to the atmosphere.

Marine Hazards: The normal marine hazards of fire, storm, flooding, grounding and sinking have been considered in relation to the nuclear merchantman. The usual design considerations for these hazards apply except that the fire hazard is less due to the absence of oil fires in boilers.

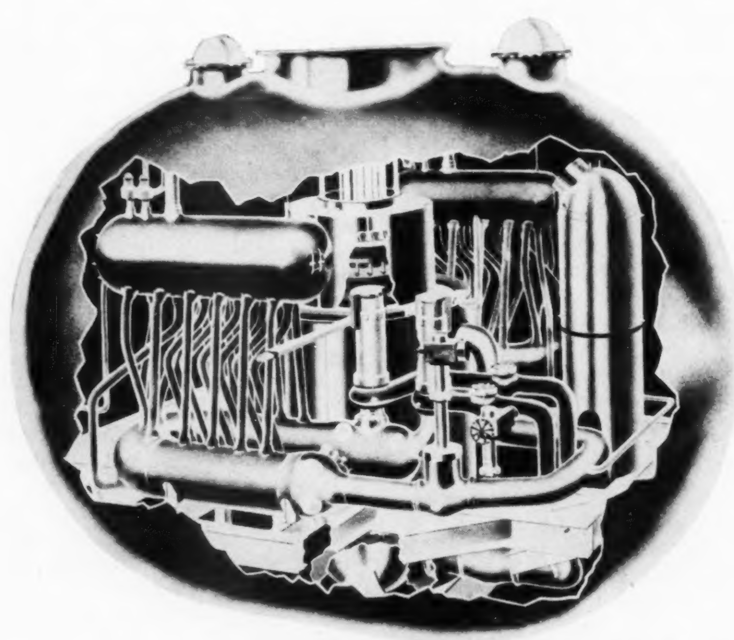
One of the designers' principal problems was that of collision and sinking. In order to locate the reactor in a spot least vulnerable to collision damage, it was placed on the centerline as far aft of midship as possible.

Several possibilities exist in the event of sinking. Should such an accident occur, the reactor would be shut down immediately. Cooling of the reactor would proceed on emergency power as long as the ship remained afloat. If sinking occurred in shallow water, the containment vessel would remain intact and the surface exposed would carry away decay heat by convection. In deep water, automatic flooding valves or bursting discs would admit sea water into the containment vessel preventing rupture of the vessel and possible damage to the internal primary system.

The ship could sink in an upside down position; consequently, supports have been provided to hold the containment vessel in place when the ship is askew.

Refueling: Refueling is not as routine an operation as it is in conventional ships. The *Savannah* need only be refueled every three years. This will be accomplished in a special location, where the proper facilities and safety precautions are maintained.

The events of the past decade verify what, only a short number of years ago, would have seemingly been an anachronism. Who would have believed, in 1945, that twenty years later atomic-powered ships would carry the world's transport and passengers? The *Savannah* and other vessels like it will, in the fu-



Babcock & Wilcox

The containment vessel for the *Savannah's* nuclear propulsion plant measures approximately fifty feet long and thirty-five feet in diameter. Shown in this cutaway view of the vessel are, in the lower left, the U-tube heat exchanger; above the exchanger, the pressurizer; and, in the center, the reactor.

ture, fill the needs of the operators of the nation's large passenger and cargo ships. Its appearance heralds the beginning of the age of extensive peacetime use of atomic energy.

SHIPPINGPORT

(Continued from Page 15)

could occur will indicate the extent of the safety precautions taken at Shippingport.

The first accident is the possible loss of coolant in the primary system by a rupture in piping or vessels. While extensive care is taken in the design and manufacture of the components of the pressurized system, and while they are tested for faults before installation, the possibility of rupture and the subsequent hazards therein have been studied quite extensively.

For any rupture large enough to be serious, the water level in the pressurizer and the reactor plant pressure would fall immediately and quite sharply. An alarm would sound when the pressure went below 1850 psia, and a set emergency procedure would then be initiated. When the pressure reached 500 psia, a safety injection system would immediately pump enough water into the reactor coolant system to prevent melting of the fuel assemblies and subsequent release of fission products. But if the rupture occurred below the core, the safety injection system would take time to cover the core with water. Some melting would occur with release of radioactive products. However, biologically speaking, the total amount of radioactivity released into the vapor tight steel pressure vessel would represent only 1.4 per cent of the activity present during a normal plant shutdown. The major portion of the fission products would remain within the fuel material during the melting. The vapor tight steel vessel or plant container, into which the water from the primary system would flow in the event of a rupture, could withstand the maximum pressure that would develop from the most extreme break.

The second major accident that could occur has already been briefly mentioned. That is a so-called "run away" nuclear reaction. In such an occurrence the reactor power level would suddenly increase faster than desired, and in time local heating of the fuel elements would result in melting of the zirconium cladding and release of radioactive particles into the primary system. Even if all protective circuits and systems failed, permitting this to happen, the reactor would soon shut down after this point is reached; thus, keeping all fission products within the primary loop and the plant container and prohibiting a nuclear explosion. This is because steam would form in the coolant channels of the reactor core at the points of local heating; and since steam is not an effective moderator of neutrons, the fission rate (controlled by the number of thermal neutrons formed from fast neutrons being moderated by contact with water molecules) would immediately decrease.

Only two of many possible accidents that could occur have been mentioned, but scientists have investigated all which are theoretically possible and have installed many safety systems to protect personnel from the effects of these accidents.

In spite of the successful operation of Shippingport, one cannot predict in glowing terms that the age of nuclear power is here, bringing with it untold benefits for man. For at present the power from Shippingport cannot compete economically with that generated from conventional power stations. Nor can the overly optimistic advocate of nuclear power point to the quantity of power being produced now or in the near future as an indicator of things to come because presently only 81,000 kilowatts of electricity are generated from nuclear power stations in this country; and only 200,000 kilowatts in the entire world come from atomic power plants.

But the Shippingport Station should not be a disillusionment, for it was not designed to compete with conventional power plants. The value in Shippingport lies in the full scale laboratory it offers to scientists to test and evaluate their ideas and find out their mistakes. No doubt many of the station's facilities that have been discussed here will be surpassed by more efficient equipment. But many of the ideas for this new equipment will have come from the Shippingport experiment. In the history of nuclear power, Shippingport will not be remembered as large or economical. These adjectives must be left to stations not yet built. But it will be remembered as the pioneer in nuclear power.

QUALITY CONTROL

(Continued from Page 17)

it embraces in its applications all of the other fields of engineering.

The modern quality control engineer's job is to put into practice, direct, and coordinate all of the theories of quality control. In accomplishing this, he faces a wide variety of problems. He must cope with a human relations problem resulting from the wide distribution of responsibility throughout the organization for product quality and the consequent difficulty of tracing any particular responsibility to a single individual or group. Closely related to this is one of the greatest overall problems in any complex organization, that of communications between individuals and between departments. Quality control is especially affected with disputes arising over responsibility. Usually, the more direct a communication is the more effective one. However, the larger an organization becomes, the more indirect its communications usually become.

Another prime concern of the quality control engineer is the generation of a feeling of quality-mindedness throughout the organization or company. With quality-mindedness, the individual, not only realizes the part his job plays in producing a quality product, but also contributes his full active support towards this goal. The establishment of this attitude is more important than any mechanical aids for checking or controlling quality.

The growth of industry has caused a vast increase in the demand for more precision in the quality characteristics of a product. Here, the quality control engineer faces a continuing technological problem. New products and developments were all made possible through the ability to achieve precision on a large scale. Such items

as the micrometer, precision gauge blocks, high speed steel, the centerless grinder, and even the electron microscope all have contributed toward increasing the precision of manufacture. This increase in precision and its related problem of control will continue as long as science and industry continue to move forward.

The modern quality control engineer should have an engineering education, and also be acquainted with such varied fields as statistics, accounting, engineering economics, industrial management, and human relations. This last quality is probably the most vital.

Such a heterogeneous background is necessary for the quality control engineer must not only know his own field, but also have a close familiarity with most of the other operations in the company such as accounting, engineering, and manufacturing. This will enable him to organize in the company the most effective quality control system which will insure production at the most economical level, while still satisfying customer demands. Perfection would be the result of a completely successful system set up on that basis.

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METALLURGY

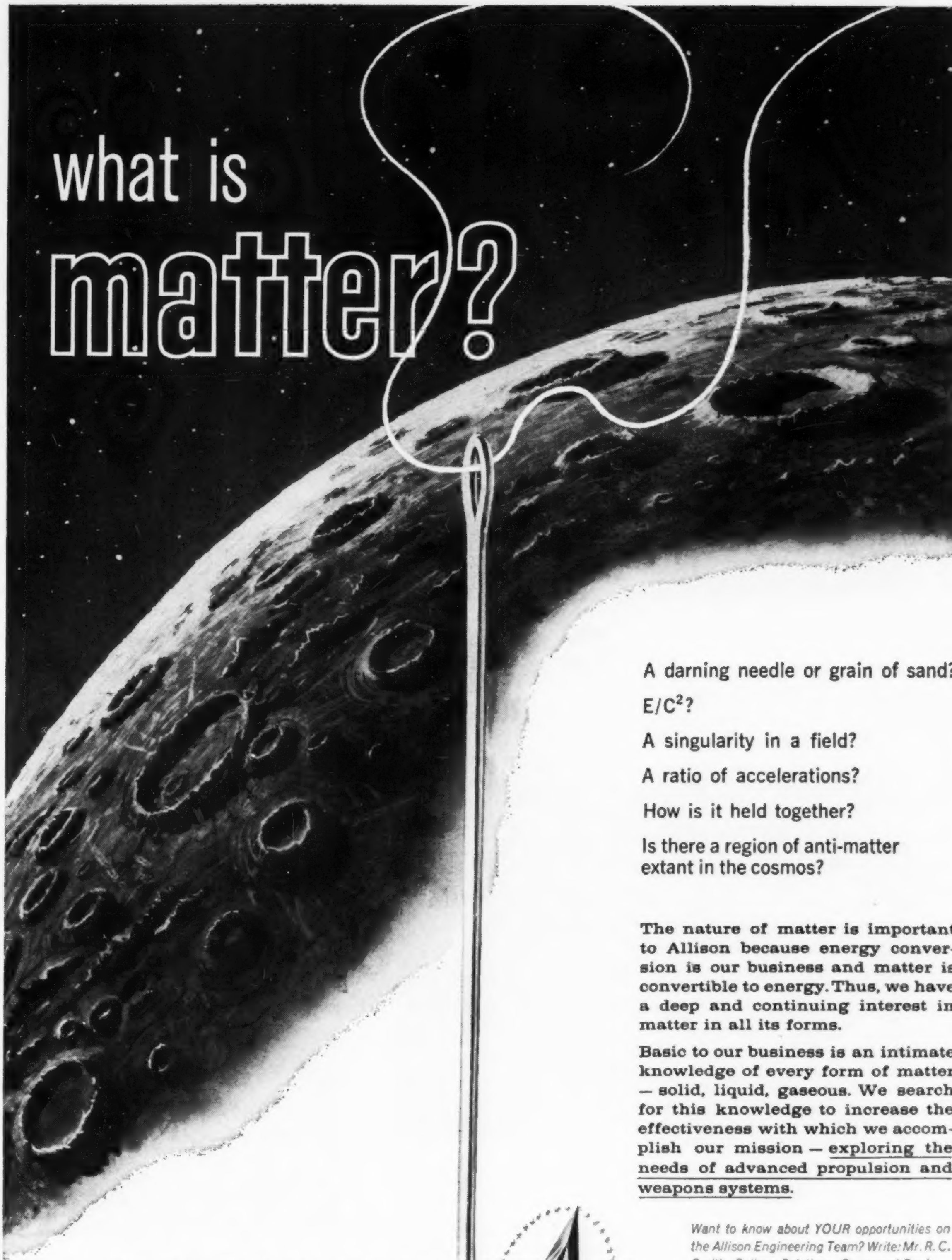
(Continued from Page 21)

ence of carbon. Then, given the proper hammering, the object would to a large degree, achieve the desired hardness.

The next discovery was quenching. Through quenching, the structure of the metal at red heat is maintained by cooling the metal so rapidly that the transformations taking place on slower cooling do not have a chance to occur. This technique was hard to grasp since it had the opposite effect on metals in earlier use. Finally the technique of tempering, reheating the metal to almost red heat and then cooling it slowly to remove internal stresses was developed. With the use of these three metal-working techniques, the iron age really began, for men could now vary the ability of the metal to be hardened and could control the hardness and brittleness of the steel produced.

In Egypt the sequence of development of these techniques was: carburization—1200 B.C., quenching—800 B.C., and tempering—700 B.C. In other regions where the technology of iron-making was less retarded, comparable but earlier dates for these developments are found. In the Near East and Asia Minor the peak of ancient iron metallurgy came around 800 B.C.

The discovery of iron was the last important metallurgical development of prehistoric times. From that time on, metallurgy was no longer a craft based on fortunate accidents alone, it was the beginning of a science.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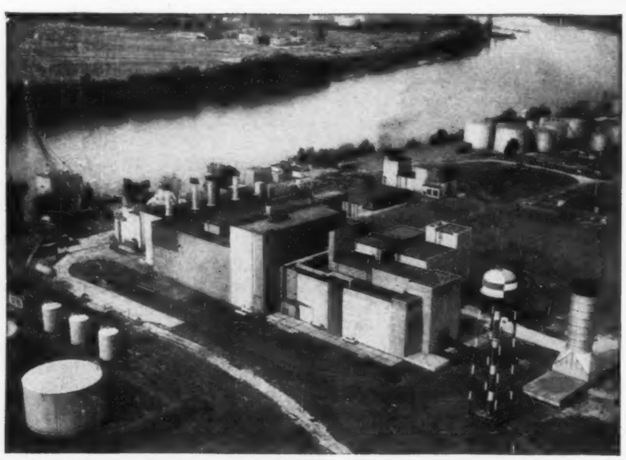
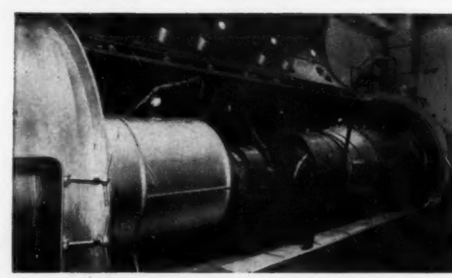
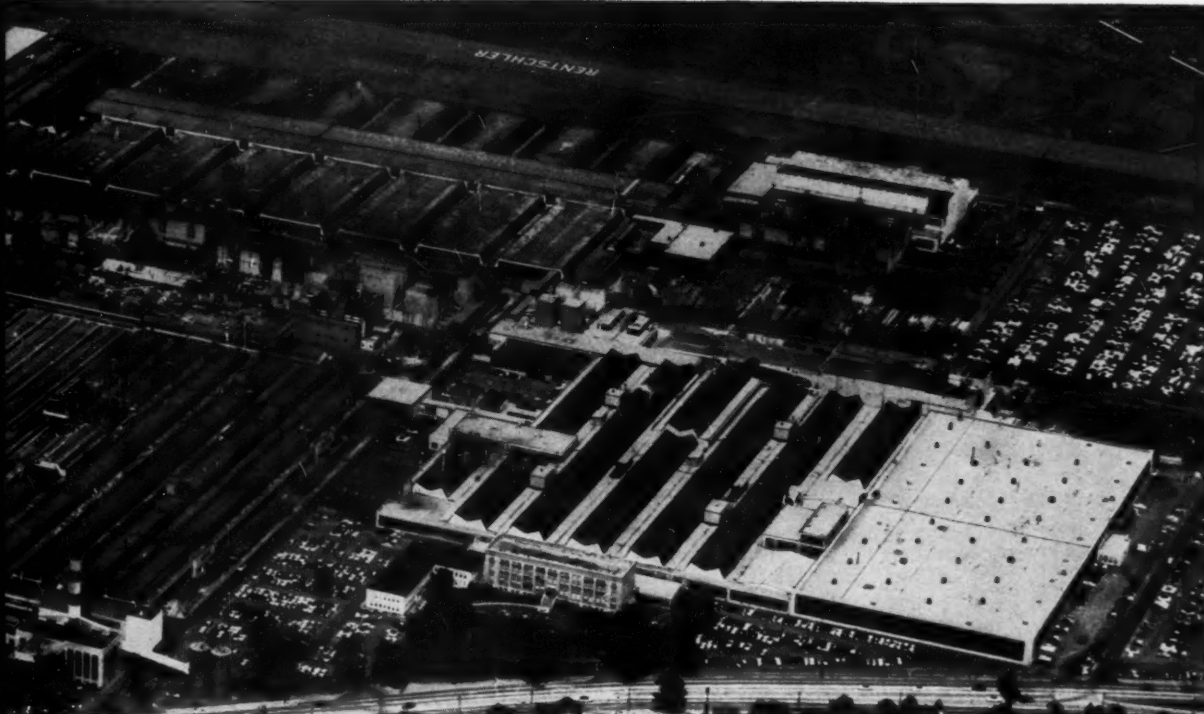


The Willgoos Turbine Engine Test Facility is the world's most extensive privately owned turbine development laboratory. Designed and built specifically to test full-scale experimental engines and components in environments simulating conditions at extreme altitudes and speeds, it is currently undergoing expansions that will greatly increase its capacity for development testing of the most advanced forms of air breathing systems.



In chambers like this at the Willgoos Turbine Engine Test Facility full-scale engines may be tested in environments which simulate conditions from sea level to 100,000 feet. Mach 3 conditions can also be simulated here.

In the new Fuel Systems Laboratory engineers can minutely analyze the effects of extreme environmental conditions on components of fuel systems — conditions such as those encountered in advanced types of flight vehicles operating at high Mach numbers and high altitudes. Fuel for these tests can be supplied at any temperature from $-65°F$ to $+500°F$.



OPERATIONS

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The Connecticut Aircraft Nuclear Engine Laboratory, operated by Pratt & Whitney Aircraft, is situated on a 1,200-acre tract near Middletown. The Laboratory was specially built for the development of nuclear flight propulsion systems.

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DIRECT FREEZING PURIFIES SALINE WATER

With both an increase in population and a per capita increase in the amount of water used, the United States is faced with a possible water shortage. Too rapid use of water near some urban areas has caused a sharp lowering of the water table, and, in those areas near the ocean, replacement of the fresh ground water by salty ocean water. In some urban and suburban communities, even in the East, water consumption is controlled during the summer months.

The more arid countries of the Middle East, faced as they are with an explosive population growth, are in a worse situation. Their nascent industries may very well be hindered in development by water scarcity. For example, one pound of rayon fiber requires about two pounds of water, and one ton of steel requires 1.5 tons of water for manufacture.

Working with a grant from the United States Department of the Interior, Professor Herbert F. Wiegandt, of the School of Chemical and Metallurgical Engineering, is studying the feasibility of freezing salt water to obtain fresh water.

Water on Shipboard

The problem of obtaining fresh water from salt water is not new. Ocean-going ships have sometimes carried stills and the necessary fuel for the stills instead of carrying the fresh water required for extended voyages. Their approach is one way of achieving fresh water from salt water; namely, distillation.

Another approach is to use ion exchange methods, in which membranes and electric currents are used to separate the unwanted mineral ions from the water.

Freezing Salty Water

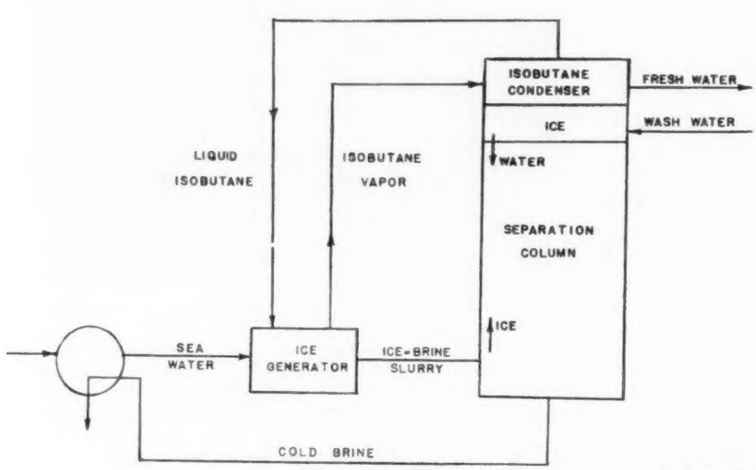
A rather different approach is to freeze the saline water. The ice which is formed is salt-free (and the residual brine more salty.) The Russians are thought to be working on this approach, and an Israeli engineer, Mr. Alexander Zarchin, has presented plans for a process to his government.

The method developed by Professor Wiegandt is not similar to the method most people use to obtain ice—filling a tray and putting it in the refrigerator. An expanded ice-cube operation would be very expensive and inefficient engineering. Water is the cheapest and most plentiful natural resource. In the United States, cities pay 30¢ per 1000 gallons of drinkable water; irrigation water is much cheaper: 12¢ per 1000 gallons. The freezing system must be carefully designed for eventual economy and simplicity.

In Professor Wiegandt's method, an immiscible refrigerant vaporizes in direct contact with the brine. The heat needed to vaporize the refrigerant is obtained from the brine (which is at a temperature of 24 degrees Fahrenheit). The brine separates into ice and more concentrated brine. The vaporized refrigerant is then compressed and condensed before again being available to freeze more water.

The ice-brine slurry passes into a separation column. Fresh water is introduced into the column and washes the ice free of brine. The ice floats at the top of the column, the wash water is in the middle, and the brine is at the bottom,

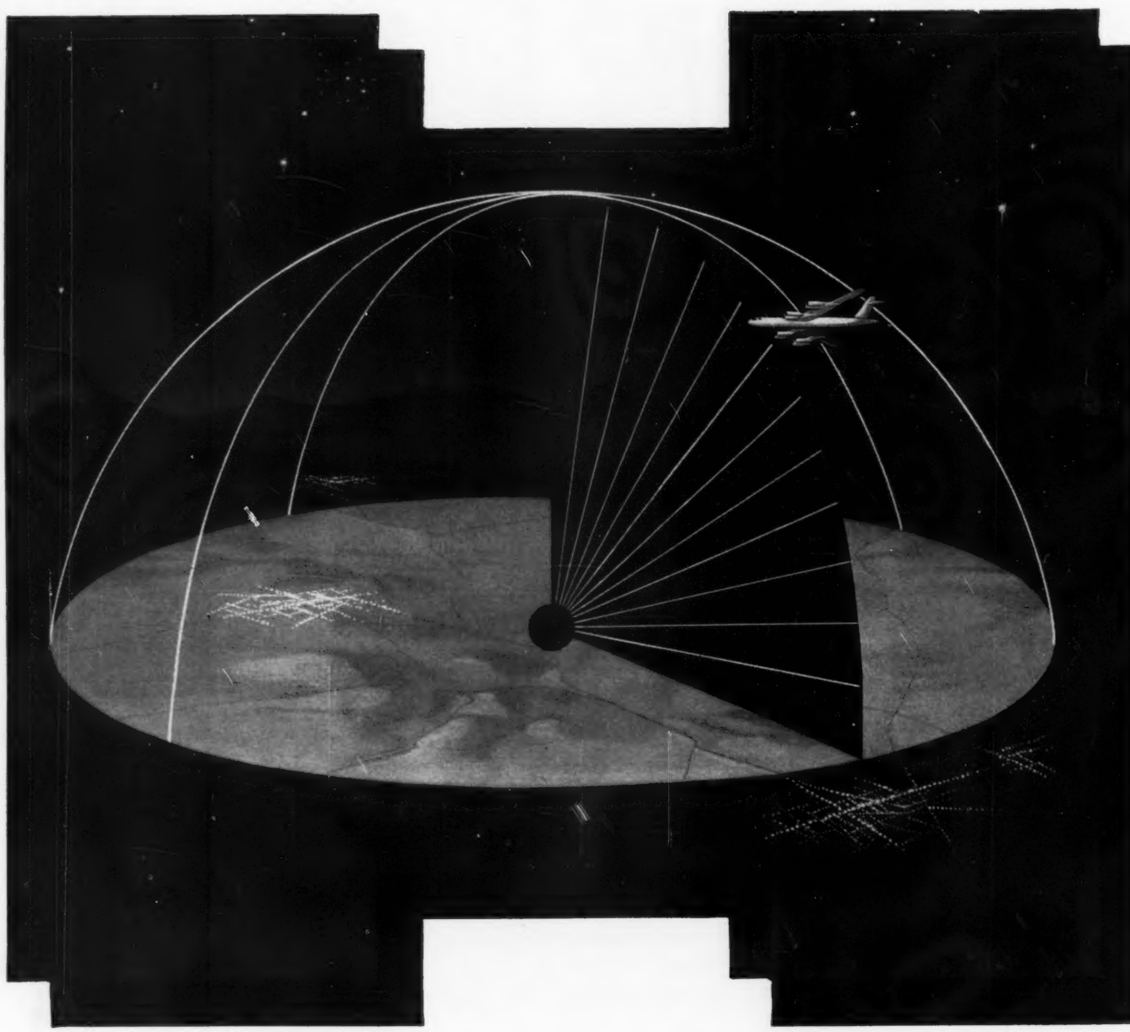
(Continued on Page 51)



Steve Garrell

A simplified schematic of the direct-freezing process shows that the cooled brine from the separation column can be used to pre-cool the sea water before the latter reaches the ice generator.

MAKING UMBRELLAS



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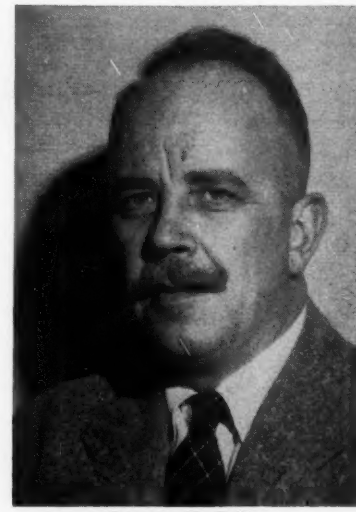


Roscoe H. Fuller

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationship between the College and its alumni."

President's Message — SOME THOUGHTS ON TECHNICAL EDUCATION

A great deal has been written in recent months about the shortage of engineers in this country. Figures are widely quoted to indicate that our principal ideological competitor annually graduates twice as many as we do, and that 90 per cent of their technical graduates stay in technical fields (to the presumed benefit of scientific progress) compared to about 50 percent here.

There is reason to be concerned; the more particularly since the disparity seems to be increasing. How complacent dare we be about this situation?

It may be argued that Engineering in Russia is less broadly based; less well-rounded than we think an engineering education should be. Without denying their individual competence within narrow fields we may feel that our engineers are a somewhat superior breed, able to operate effectively over a broad enough area so that one of ours is worth two or three of theirs. The fact that so high a proportion of our engineering graduates are successful in other fields is in itself some indication of the truth of this argument. One may indeed wonder what change would be made in the 90 percent figure if Russians were free to change jobs.

Perhaps we may even justify the comparison to our own advantage by adding to the number of our engineering graduates all of the people who annually come up from the shop into engineering specialties, the "Associates in Engineering" from the many junior colleges and technical institutes and the trade school graduates who acquire competence in specialized fields through technical training on the job. This does help the picture, and we should not sell these men short.

But the thing that should really worry us, I think, is the trend in our education; the apparent acceleration of the disparity between ourselves and our opponents. Our situation is not getting better, but worse, in spite of all the comforting comparisons we can marshal.

Let us look, for a moment, at our secondary schools. Fifty years ago nearly every public high school required at least one year of algebra for all students. Today that requirement has been relaxed to a point where less than half as many high school graduates have taken algebra as in 1908! If this is the case with elementary mathematics, it is much worse in the sciences. In many high schools, trigonometry is not even taught!

This is the place where some effort had better be expended, and soon! If we don't find a way to turn the "progressivists" out of our public school system, to return to some degree of rigor in secondary education, to foster the thought that mathematics and science are a more worthwhile part of an educated man than "group adjustment" or "self-expression" we shall find ourselves not only short of scientists, but short even of those qualified to see the danger in our situation. Here is where the need is, and the need is urgent.

—Roscoe H. Fuller

ALUMNI ENGINEERS

Philip Will Jr., Arch. '28, became first vice-president of the America Institute of Architects at their recent convention in Cleveland. Around forty Cornell architects attended this convention, including George B. Cummings, Arch. '12, who was recently national president of the institute. One of the many discussions of the meeting was concerned with the necessity of making better construction cost estimates. If the architect is to effectively combat the "package" attraction, he must make his services as complete as possible.

Robert O. Davison, ME '21, is chairman of the Dairy Industries Supply Association Exposition Committee, an exposition which is attended by about twenty-five thousand people. He is presently serving his second term as director of the association, and is eastern division manager of Kelco Co. chemicals.

Paul W. Drake, Arch '21 was recently reappointed to the New Jersey State Board of Architects by Governor Meyner, and is vice-president of that board. Mr. Drake is also a member of the board of directors of the National Council of Architectural Registration Boards. He conducts an architectural practice with the firm of Drake, Tuthill, Convery & Cueman in Summit, New Jersey.

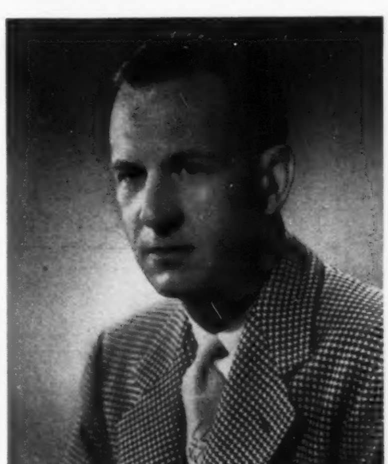
Richard M. Gooley, BEE '52, is a technical advisor and evaluator for the Navy's BuPers in connection with a new, advanced fire control technician school at Great Lakes Naval Training Center. Mr. Gooley is a field engineer for Western Electric.

Herbert F. Moore, ME '99, MME '03, research professor of engineering materials, emeritus, University of Illinois, was honored at a luncheon in Urbana, Illinois, in November by the American Railway Engineering Association and the American Iron & Steel Institute. A bronze plaque will be presented to the University of Illinois in recognition of Professor Moore's pioneering and pre-eminence in the study of the fatigue properties of metals and especially his successful direction from 1931-44 of the joint investigation of fissures in railroad rails, which contributed to the safety and economy of railroad operation. The plaque will be placed in Talbot Laboratory. Professor Moore was an instructor in Machine Design at Cornell from 1900-03.

Peter J. Winokur Jr., BEE '43, is group supervisor engineer with Philco Corp. government and industrial division. He is active with the Cheltenham Township, Pa., Science Seminar to further the science and mathematics education of school students.

Robert C. Reisweber, BME '52 is an aerodynamics section engineer with Ellicott Co., a division of Carrier Corp. Last June he presented a paper "Design and Development of a Supercharger for a Pressure-Fired Boiler," at the ASME semi-annual meeting.

Edgar H. Dix, Jr., ME '14, MME '16, was awarded the highest United States Navy civilian honor in November. Mr. Dix is the retired assistant director of research, Aluminum Company of America.



Alumni News

Philip Will, Jr.

In ceremonies held in the Pentagon, Garrison Norton, assistant secretary of the Navy (Air), presented to Mr. Dix the Distinguished Public Service Award for his outstanding contributions to the Navy in the fields of scientific research and development.

Recognized internationally as the dean of aluminum metallurgy, Mr. Dix retired from Alcoa September 1, 1958, following forty years of service with the company. He has been directly or indirectly responsible for the development of the majority of aluminum alloys in use today, according to Alcoa officials.

The Navy citation states, in part: "As assistant director of research of the Alcoa Research Laboratories of Aluminum Company of America, Mr. Dix was the guiding intellect in the development of high strength, corrosion resistant aluminum alloys which constitute the basic construction material in modern, high performance naval aircraft. Mr. Dix has devoted a lifetime to aviation in general; naval aviation, in particular, has benefitted greatly from his achievements. His vision, technical competence and efficient leadership have resulted in outstanding contributions to the nation's defense capability."

Arthur J. Maahs, CE '22, is manager of sales engineering for Johns Manville pipe division, a position to which he rose in 1953 after serving as staff engineer and chief engineer of the transit pipe division. Mr. Maahs was recently honored by being inducted into the J-M quarter century club at a dinner ceremony at the Commodore in New York and given special commendation on his record of achievement by the chairman of J-M, A. R. Fisher.

Victor J. Goetz, BSAE '50, has been appointed quality control supervisor, glass container plant, with Continental Can Co. His new position is with the Hazel-Atlas Glass Division in Washington.

Top Engineer-Journalist

What's in a brain? Carroll (standing) gets an advanced briefing on the latest developments in the Univac Electronic Computer from Charles Katz of Remington Rand.

COLLEGE NEWS

Edited by J. L. Schoenthaler, ME '61

SPACE RADAR SITE CHOSEN IN PUERTO RICO CANYON

Cornell University's proposed giant radar will be located at a site in Puerto Rico (Nov. 1958).

Scientists picked the Puerto Rico location for the 1,000 foot bowl because of its relatively low latitude and because of natural depressions in the land which could be used to support the device.

Scientists had also considered a site in Texas for the big scanner. The radar, which will be as big as two football stadiums, will be used to probe out secrets of the ionosphere, the region of the atmosphere higher than 60 miles above the earth. It will also give scientists a picture of Venus' cloud-covered surface, and of the face of Mars and the Sun.

Estimated date of completion of the radar, which is being designed by Associate Professors William Gordon and William McGuire, is April, 1961. At that time, Venus will be comparatively close to earth and in a favorable position for viewing.

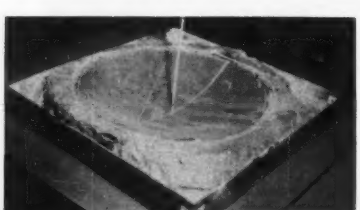
AWARD GIVEN TO EE STUDENT FOR ELECTRONIC ACHIEVEMENT

For recognition of high scholastic attainment and demonstration of outstanding potential in the field of electronics, James B. Comly of Bayside, New York, received a $250 scholarship award at Cornell University.

Mr. Sheldon Williams, Managing Director of the Blonder-Tongue Foundation, presented the award to Mr. Comly in the presence of Professor William H. Erickson, Director of the EE School, Professor L. F. Eastman, Project Advisor for Mr. Comly, and Mr. Donald H. Moyer, Director of Student Personnel for the College.

Comly resides at 702 University Avenue, Ithaca, and is a fifth year student in Electrical Engineering. He will be graduated in June, 1959.

Supported by Blonder-Tongue Laboratories, Inc., Newark, N.J., the Foundation presents this annual award to the student who shows the greatest achievement in electronics.



Gary Klock

Cornell engineers have prepared this model of a proposed radar site in Puerto Rico.

JET ENGINE RESEARCH CONCERNS SAFETY FEATURES

Cornell scientists are looking for a way to prevent rotating stall, a form of engine failure which plagues designers. The project is being carried out by Donald Earl Ordway, an Assistant Professor in the Graduate School of Aeronautical Engineering.

Professor Ordway and several graduate students have spent hundreds of hours testing jet engine compressor blades in a cascade wind tunnel. The wind tunnel, in which air is blown over a row of blades that look like a venetian blind, gives scientists a chance to study the effects of air flow on some of a jet engine's moving parts.

So far, the researchers have confined their investigations to fixed blades. The next step, to be carried out by Eric Brocher, a doctoral candidate, will be construction of a rotating device which will move the blades as if they were on an actual jet engine.

Rotating stall starts when the air near an engine compressor blade strikes it at a sharply increasing angle. The blades flutter so violently that vibrations are set up which sometimes destroy them completely. Cornell's researchers are trying to prevent rotating stall by ejecting a high velocity air stream from a slot at the rear of the blades. Known as the "jet flap principle," this process greatly decreases the possibility of rotating stall.

So far, the researchers have cut the chances of rotating stall approximately in half. If this success continues, engine efficiency will be increased and fewer stops will be necessary for fuel.

PROF. SACK (EP) TO LECTURE TO NATO AIR RESEARCH GROUP

Professor Henri Sack, currently on sabbatical leave, is now delivering a series of lectures for the Advisory Group on Air Research and Development of NATO, concerning consulting methods of studying solid state properties by internal friction measurements. Prof. Sack has recently completed another lecture series at the University of Munich, and is now living in Brussels, where he acts as a consultant to the Centre D'Etude de L'Energie Nucleaire Mol Donk.

WEATHER CONTROL ATTEMPTED BY FOURTEEN UNIVERSITIES

Cornell University's studies of the high atmosphere will give it a key role in a newly-formed Inter-University Corporation for Atmospheric Research.

The corporation, which received its official launching at the Twelfth Annual Board of Trade Gold Awards Dinner in New York, October 9, includes 14 universities from across the nation. Cornell's research on the ionosphere and on solar radiation will give it a leading part in the project. Principal figures in this research have been Henry G. Booker, Professor of Electrical Engineering and Physics, and William E. Gordon, Associate Professor of Electrical Engineering Research.

The aim of the non-profit corporation is to bring together the knowledge, methods and equipment from some of the nation's outstanding universities in an effort to learn more about the weather. Contributing scientists hope to acquire a better understanding of the relationships between the upper and

lower layers of the atmosphere. From new insights in this and other areas, they hope to devise more accurate forecasting methods.

Many of these men are also cautiously considering the possibility of eventual control of the weather. Cornell scientists say that before anything can be done about weather control, more must be learned about the weather itself. They add, however, that knowledge originating from inter-university endeavor may provide the means of such control.

AEC GRANTS REACTOR LICENSE TO CORNELL

The Atomic Energy Commission has officially granted the University the right to build its atomic reactor (May 1958 issue). The University has been given a class 104 license for a dual core reactor known as the "facility." Under the terms of this license, the University must have the reactor completed no earlier than June 30, 1959 and no later than January 31, 1960. This, of course, does not include the introduction of fuel material which is to be furnished by the Commission. The license, however, will expire after a period of twenty years from the date of the construction permit.

The AEC has allocated 68 kilogram, of U-235 for the reactor which it terms as, "A light water moderated, dual core instructional and research reactor designed to operate at a thermal power level of ten kilowatts for research and at thermal power levels of less than ten watts for instruction." This dual core reactor will be controlled by a single system of instrumentation and control, and only one of the cores may be in operation at the same time.

Although the reactor is to be located on the southern edge of the campus with the nearest residence only 300 feet away, the AEC still considers the safety features as being more than ample. The reactor has intake and exhaust ducts with tight dampers which close automatically, shielding of eighteen inch concrete walls and a 20,000 cubic foot capacity dry-type gas holder, which is capable of being fed from the building by a purge pump. This will be sufficient to keep the building under a below atmospheric pressure for at least five days if trouble develops. Another safety factor is the mechanical limitation to control rod withdrawal. This limits the amount of excess radiation to only 1 per cent.

The reactor was designed by Cornell University staff members, and the further design and modifications were by the Vitro Engineering Co. The operating cost will be met by appropriations to be included in the University's budget.

MACHINE DESIGN SEMINAR FEATURES MECHANISMS EXPERT

Dr. Rudolf A. Beyer, of the Technical University of Munich, Germany, spoke on the synthesis of mechanisms with practical applications on November 4 at Upson Hall. Dr. Beyer, a well-known figure in the field of machine design, has written many books on kinematics of machinery, the most recent being *Synthesis of Plane Mechanisms* and *Elements of Space Mechanisms*. He is in the United States at the invitation of some two dozen universities to further mechanisms research here.

Dr. Beyer finds "kinematics in good hands" here, but hopes that more intense interest can be developed. Interest in this field is relatively recent compared to that of Germany.

Synthesis of mechanisms involves achieving certain definite positions of a link in a time relationship with a specified motion. The more the number of required positions, the more difficult is the design. Dr. Beyer used a sewing machine as an example: one knows the needle must traverse a point a specified number of times, and it behooves the designer to achieve this specification given a source of motion, usually a rotating shaft. Dr. Beyer spoke only of one method of design, but emphasized that there were many more. The seminar concerned itself primarily with synthesis of plane mechanisms of one, two, three, and four, required positions.

AERO LAB TO AID RESEARCH IN MID-AIR COLLISION PROBLEMS

The recently created Federal Aviation Agency, charged with developing a better airway, airport and control system for the nation, is receiving aid from Cornell Aeronautical Laboratory, Inc.

Under a contract with the Bureau of Research and Development, FAA, the Laboratory is conducting scientific research on several tasks, valued at slightly over $100,000. Particular attention is directed at mid-air collision problems, the Lab reported.

In a major task, the Laboratory is studying conditions of civil and military test flight operations in the highly saturated Southern Califor-

University News Bureau

Mr. Sheldon Williams, right, Managing Director of the Blonder-Tongue Foundation, presents a $250 scholarship award to James B. Comly, EE '59, for achievement in the field of electronics. Looking on is Prof. W. H. Erickson, Director of the School of Electrical Engineering.

nia region. Recent mid-air collisions have emphasized the threat in that area.

Test flights of both military and civil aircraft are vital to aeronautical progress. These flights compose a significant segment of flight activity in the nation's airspace, particularly in Southern California. FAA hopes to avoid unreasonable restraints of such activity and yet provide maximum safety.

In another task, CAL is studying programs for testing the utility of an airborne proximity warning indicator to assist pilots in avoiding mid-air collisions. It also is investigating all the means currently available which help pilots to see other aircraft in their vicinity.

Other work for the Bureau includes research into simulator inputs, including flight trainers, as a means of developing an improved air traffic control system. CAL is also studying aircraft take-off and landing performance as an aid in airport design.

As an overall guide for determining airport and air traffic control requirements, CAL will analyze the performance of several categories of aircraft. These include jet fighters, jet and piston-engined transports, seaplanes and smaller, private-type aircraft.

In addition to its current work, CAL expects that future research tasks will be assigned to it by the Agency's Research and Development Bureau.

The Laboratory has a broad background of research into problems of air operations. Several previous projects covered mid-air collision devices.

CAL also contributed to two special reports to the President on air operations, including the recent report by Edward P. Curtis dealing with a 20-year forecast of aviation's growth. The latter report contributed heavily to new federal organization and planning for aviation.

SIMULATION OF MACHINE SHOP BASIS FOR IE RESEARCH

Richard W. Conway, assistant professor in the department of industrial engineering, is heading a research project entitled "Investigation of Digital Systems Simulation." The project is being sponsored by the Logistics Branch of the Office of Naval Research. Dr. Conway is being assisted by two graduate students in the department, Bruce Johnson, Rutgers, ME '55, and William Maxwell, Cornell, ME '57.

The project deals with the problems encountered in a production machine shop. An IBM 650 computer is being set up in representation of the operation of a shop. It is programmed to simulate the operating characteristics of the machines and the shop in general. From these characteristics, the efficiency of various methods can be determined. The results will include such details as effective scheduling of production and determination of required equipment.

This system will be useful in both education and industry. Graduate students will use it to test their theses and compare them to accepted ideas. Industry will use it to improve the efficiency of their shops.

The project was begun last May. To date, two papers have been completed. The first was presented last October at the fifth international meeting of the Institute of Managerial Sciences. The findings have already been sent to various universities for the use of their graduate students and to industries anxious to improve their production techniques.

FACULTY MEMBERS ATTEND ASME ANNUAL MEETING

The annual meeting of the American Society of Mechanical Engineers was held in New York during the first week of December. Several members of the staff of the Sibley School of Mechanical Engineering participated.

Prof. G. B. DuBois presented a paper entitled "Surface Finish and Clearance Effects on Journal—Bearing Load Capacity and Friction," which was prepared by Prof. DuBois and Prof. F. W. Ocvirk. Prof. H. N. McManus Jr. presented a paper entitled "The Effect of Fuel Types and Admission Methods on Combustion Efficiency." The paper was prepared by Prof. McManus in conjunction with Prof. W. E. Ibele and Prof. T. E. Murphy, both of the University of Minnesota.

Many professors were members of special committees. Prof. H. J. Loberg, Director of the Sibley School, participated as a member of the Professional Division's executive committee, which reported on a sponsored research project on engineering education. Prof. B. W. Saunders was a member of the executive committee of the Materials Handling Division. Prof. D. G. Shepherd was on the executive committee of the Gas Turbine Division. Prof. B. Gebhart acted as adviser to the Student Branch of ASME.

Other Faculty members participating in committee work were Prof. R. M. Phelan, Prof. A. H. Burr, and Prof. W. C. Andrae.

VACUUM INDUCTION FURNACE TO BE USED FOR INSTRUCTION

Students of metallurgical and nuclear engineering at Cornell University will learn the latest techniques of vacuum melting and refining with the help of a new Stokes induction heating, vacuum furnace.

The unit has its own complete vacuum pumping system, which consists of a series of pumps, including a mechanical pump whose intake corresponds to the exhaust of two "booster" pumps. This system is capable of producing a furnace chamber pressure of less than a micron of mercury, about a millionth of a standard atmosphere.

Metal is melted in crucibles by induction heating with water cooled coils in the vacuum chamber. Current through the coil is provided by a thirty kilowatt motor-generator at a frequency of 4500 c.p.s. The voltage across the coil, and therefore the current, is controlled at a console near the furnace. The crucible of molten metal can be tilted by operation of a lever at the side of the vacuum chamber. This enables the metal to be poured into a mold. This vacuum processing furnace is capable of melting and pouring seventeen pounds of metal.

The furnace was purchased with a grant from the Atomic Energy Commission. Instruction in its use is being supervised by Prof. James L. Gregg of the Chemical and Metallurgical engineering school. It is one of the first of such units to be installed in an American university primarily for undergraduate educational purposes.

MECHANICS AND MATERIALS DEPT. ANNOUNCES FACULTY ACTIVITIES

Three professors have recently completed papers. Prof. T. P. Mitchell of the Department of Mechanics and Materials will present his paper, entitled "The Nonlinear Bending of Thin Rods" at the annual meeting of the American Society of Mechanical Engineers, December 1, at New York City.

Analytical Chemistry Journal will soon publish two papers by Prof. A. L. Ruoff. The papers are "The Diffusion Analogy for Fluid Flow in Paper" and "Analysis of a Nonuniform Pore Model for Fluid Flow."

Prof. J. W. Dally has recently coauthored a paper "Photoelastic Study of Stress Wave Propagation in Large Plates." It was presented November 14 at Albany, New York, at the annual meeting of the Society for Experimental Stress Analysis.

Prof. P. P. Bijlaard's study, "Method of Split Rigidities and its Applications to Various Buckling Problems" was published in July, 1958 by the National Advisory Committee for Aeronautics. Prof. Bijlaard has also completed a series of reports on the theory of "Stresses in a Spherical Vessel" for the Pressure Vessel Research Committee, and this theory is now being investigated for experimental confirmation by Prof. J. W. Dally. Prof. Bijlaard has also written "Differential Equations for Cylindrical Shells," which appear in the September 1958 Journal of Aero Space Sciences, and his theory on buckling appears in "Ausbeulen" by Kollbrunner and Meister, recently published in West Germany.

The Department is now engaged in a research program to determine experimentally the feasibility of using coated nylon as a parachute material at 2,000 degrees Fahrenheit and Mach 5 (3000 mph). The experimental work was done in a hypersonic wind tunnel at the Arnold Engineering Development Center in Tullahoma, Tennessee, by Messrs. R. H. Cornish, C. W. Beadle, F. J. Ahimaz, and D. Wintringer. They are working under the auspices of the Wright Air Development Center.

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TECHNIBRIEFS

Edited by R. A. Wolf, EP '61

ARMY RADAR SYSTEM PERFORMS THREE TASKS SIMULTANEOUSLY

A new "three dimensional" radar system which detects airborne targets at extreme range and for the first time simultaneously computes distance, bearing, and altitude has been developed for the Army by the Hughes Aircraft Company.

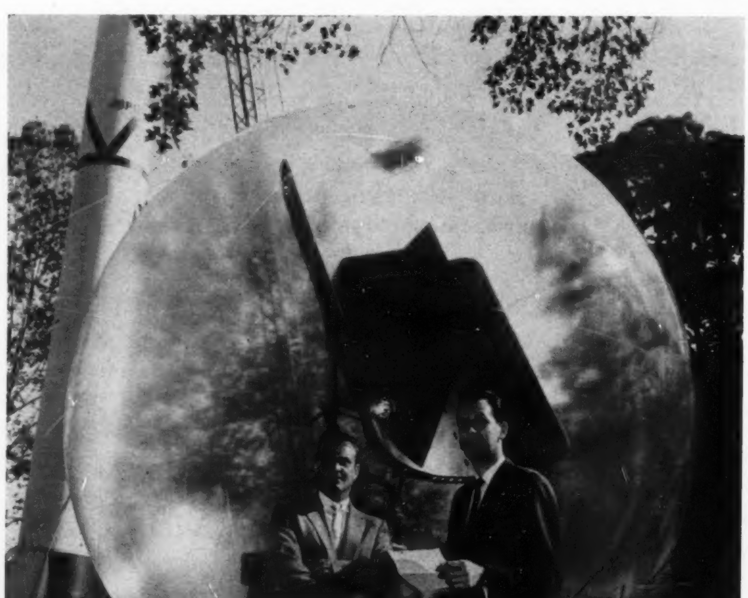
Called Frescanar, the new radar system is the eyes of the "Missile Monitor," an air defense guided missile fire distribution system for mobile use with a field army. The new radar device is considered one of the most important advances made in electronic detection since the development of radar.

The Frescanar system concentrates all available power into sharp pencil beams of energy flashing on and off in fan-shaped array to pinpoint targets at great distances with extreme accuracy. The electronic beam scans rapidly and greatly increases the number of targets which can be tracked at the same time. It provides better separation of closely-spaced targets with a minimum of ground clutter.

The amount of auxiliary equipment necessary with the system is also greatly decreased since Frescanar computes range, bearing, and altitude at the same time and also requires only one operator and master control while conventional systems require two or more of each to achieve similar results. Thus, the weight of the system and the number of personnel needed are sharply reduced. The entire system consists of an equipment van, a power truck, and an antenna trailer.

In use, an inflatable radome of fabricated nylon vulcanized to two layers of neoprene-coated fabric and weighing about six hundred pounds envelopes the operating antenna to protect it from wind, snow, and ice.

As it is used by the Army in the field, the radar detects targets and three-dimensional information is fed electronically to the radar data processing center. Here the data is converted into digital form and is sent to various key points of the command. Thus, the group commander can have complete information on the aircraft in his area instantaneously and can assign targets to appropriate batteries.



Hughes Aircraft Co.

This huge antenna simultaneously detects in three dimensions, distance, bearing and altitude, of multiple airborne targets for the revolutionary Frescanar radar system. The plastic radome surrounding the antenna is made of a fabricated nylon vulcanized to a neoprene-coated fabrid, and serves to protect the antenna from wind, snow, and ice.

TINY MAGNETIC RODS HELP COMPUTERS THINK FASTER

The National Cash Register Company has developed a magnetic device the size of a pin which promises to increase the "thinking" speed of future electronic computers ten to twenty times and make possible new missile and satellite advances. It can be used both as a switching and information storage element.

The device consists of a glass rod about fifteen thousandths of an inch in diameter, which is given a magnetic coating by a special electro-chemical process. Small windings of wire around the rod store the information.

The new glass rod devices are expected to find many applications in the field of commercial data-processing systems. By handling information much faster than conventional switching and memory units, they will reduce the amount of equipment necessary for any given task. The actual top speed of the device is as yet unknown. However, research models have exhibited switching times as low as four millimicroseconds. Another feature of the new computer components which will make them useful in computers is that, in contrast with present memory devices, the rods lend themselves to fairly inexpensive production techniques.

The rods will also make possible lighter computer units in missiles and satellites because they require very little space for the storing of information. For example, a memory system the size of a pack of cigarettes could store eight thousand bits of information. Improved techniques in the winding of wires around the rods will make even greater compactness possible. The new system also reduces the required size of the source of power because of its very low consumption of current. It takes only one twenty-thousandth of a watt to store one piece of information on a rod.

Another property which will make these rods useful in missiles is their insensitivity to temperature. A magnetic rod can operate at a temperature three hundred degrees higher than the conventional components.

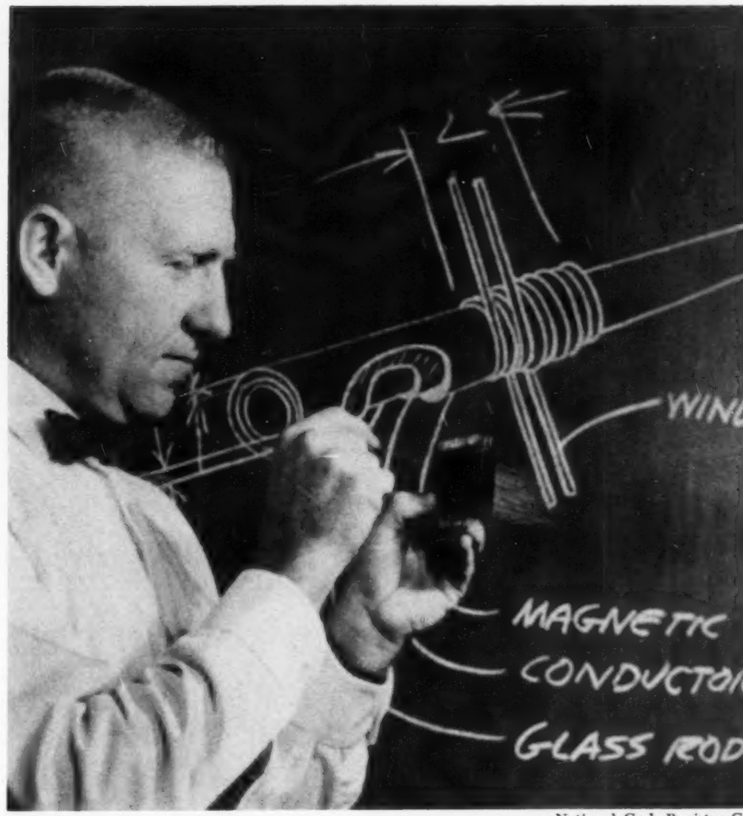
SUPER-PRECISE EXPERIMENTS CONFIRM RELATIVITY THEORY

A unique, high-precision experiment performed by scientists from IBM and the physics department of Columbia University has given strong further confirmation of Einstein's Special Theory of Relativity.

According to the Theory of Relativity, the velocity of any electromagnetic vibration including light is independent of the velocity of the beam source relative to any given reference system. Before the advent of the Theory of Relativity, it had been thought that no wave form could be transmitted in the absence of a medium of some kind. Scientists therefore theorized that there was a medium permeating all space, the so-called ether. However, if this were true and electromagnetic vibrations had properties similar to sound waves, then the time required for a beam of light to travel between two points a fixed distance apart would depend on the velocity of these two points with respect to the ether.

Experiments, starting with the classic Michelson-Morley experiment in 1887, generally confirm Einstein's theory by showing that, to the limit of the accuracy of the measurements, the velocity of light was constant despite differences in the velocity of the sender with respect to the ether. However, if there were any variations in the velocity of light due to the ether effects they would have to be extremely small relative to the large velocity of light; the accuracy of these experiments was rather limited because of the methods used, so that they could not establish the validity of Einstein's statement conclusively.

The recent experiments done at Columbia using a "MASER" (Microwave Amplification by Stimulated Emission of Radiation) showed that if there is a change in the velocity of light due to the differences in the velocity of the emitter with respect to the ether, then that change is less than one-fiftieth as large as had been shown in previous experiments.



National Cash Register Co.

One of the tiny rod elements is inserted into a memory assembly to demonstrate the ease with which computer components may be assembled with the use of the magnetically treated rods. Each rod element consists of a glass rod about fifteen thousandths of an inch in diameter covered with a layer of conducting material with a magnetic coating.

NEW NAVY BALLOON STAYS UP AUTOMATICALLY FOR DAYS

The Navy has recently tested a revolutionary new type of superpressure balloon which will stay aloft for days without using ballast.

In normal ballasted balloon flights, the balloon is partially inflated at launching. As the balloon rises, heat from the sun's rays expands the helium and excess gas is automatically valved off to prevent the balloon from bursting. At sunset, when the helium contracts and the balloon loses buoyancy, ballast is dropped to make the balloon system lighter and allow it to return to its original altitude.

The skin of the new Navy balloon is strong enough to withstand considerable extra pressure from the gas inside. This extra strength provides the balloon with much greater operating flexibility. For instance, before the recent launching of one of these experimental balloons, the balloon was filled with sufficient helium to carry it to an altitude of 65,000 feet. The valve was then sealed. By the time the balloon had reached the predetermined altitude, the gas had expanded sufficiently to fill the volume of the balloon completely and cause an inside pressure somewhat greater than the pressure of the air outside. The balloon's skin, however, was able to withstand this pressure and the volume of the gas did not increase appreciably. Then, at night, as the gas cooled, the volume remained the same as the pressure inside the balloon dropped to near that of the surrounding atmosphere. Thus, the system remained at a constant altitude.

The balloon used in this test had a volume of 16,500 cubic feet and was constructed of .002 inch DuPont "Mylar." The 110 feet long cylindrical balloon carried a pay-

load of approximately twenty-five pounds which included Transosonde instruments to transmit information as to the pressure, altitude, and location of the balloon.

Through the use of this strong plastic skin, a balloon can stay at a constant altitude for a much longer time than was previously possible and, at the same time, carry a larger payload because there is no necessity for ballast.

DATA FROM SPUTNIK II AIDS IN SPACE FLIGHT RESEARCH

Research on two of the problems of manned space flight has been aided by data received from Sputnik II about the condition of the small dog that lived in the Russian satellite for several days.

One of the great problems involved in a man's being propelled into space by a rocket is that he would have to undergo tremendous acceleration during his ascent. His circulation would be changed greatly since the blood would be forced toward the lowest point of his body.

The information obtained about the physiological functions of the dog in Sputnik II were interesting in this regard. According to the report of two Russian medical doctors, the frequency of the animal's heart contractions immediately after takeoff was triple the normal rate. Later, as the acceleration increased, the frequency began to diminish. The dog's breathing became shallow and fast as the acceleration increased. At maximum acceleration, its breathing rate was three or four times normal. However, the dog was able to stand the tremendous force and was in comparatively good health as the satellite began to circle the earth.

As the satellite rotated around the earth, the dog experienced complete weightlessness for a prolonged period. Humans have been subjected to this condition artificially for short periods and it is known that the muscular coordination and balance are seriously affected. However, according to the data from Sputnik, the lack of gravity produced no significant changes in the bodily functions of the dog.

The data received from the satellite generally confirms the idea that animals or humans are physically capable of space flight.

There's much more to it than just the size of the FISH and the size of the POND

We've been told that an engineering graduate is frequently attracted to companies our size because of his understandable human desire to be "a big fish in a little pond".

While it is true that (numerically speaking) our employee team is small compared to some, we encounter great difficulty in trying to think of Sikorsky Aircraft as a "little pond". Our contributions to the field of rotary-winged aircraft have not been small, nor can our field be considered limited or professionally confining. Quite the contrary. Sikorsky Aircraft is the company which *pioneered* the modern helicopter; and our field today is recognized as one of the broadest and most challenging in the entire aircraft industry.

And what of the size of the "fish"?

Unquestionably, that is a matter involving your own individual potential for growth. Like any far-sighted company, we're always willing to talk with "young whales"!

For factual and detailed information about careers with us, please write to Mr. Richard L. Auten, Personnel Department.

SIKORSKY AIRCRAFT

ONE OF THE DIVISIONS OF UNITED AIRCRAFT CORPORATION

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RESEARCH AT CORNELL

(Continued from Page 30)

when the washing operation has been completed. The favorable densities thus yield a bonus; the ice is not in contact with the brine and cannot be re-contaminated.

Energy Efficiently Used

This simple yet elegant scheme is further improved by the use of heat exchangers to conserve energy. For example, the vaporized refrigerant must be compressed and condensed to use it for making more ice. A look at the thermodynamics of the process shows that a direct contact between the compressed vapor and ice is best. The washed ice from the separation tower is thereby melted to fresh water, easier to handle than ice itself, and the refrigerant condensed. The refrigerant is separated and sent back to the ice generator for another cycle. The fresh water is pumped out as product.

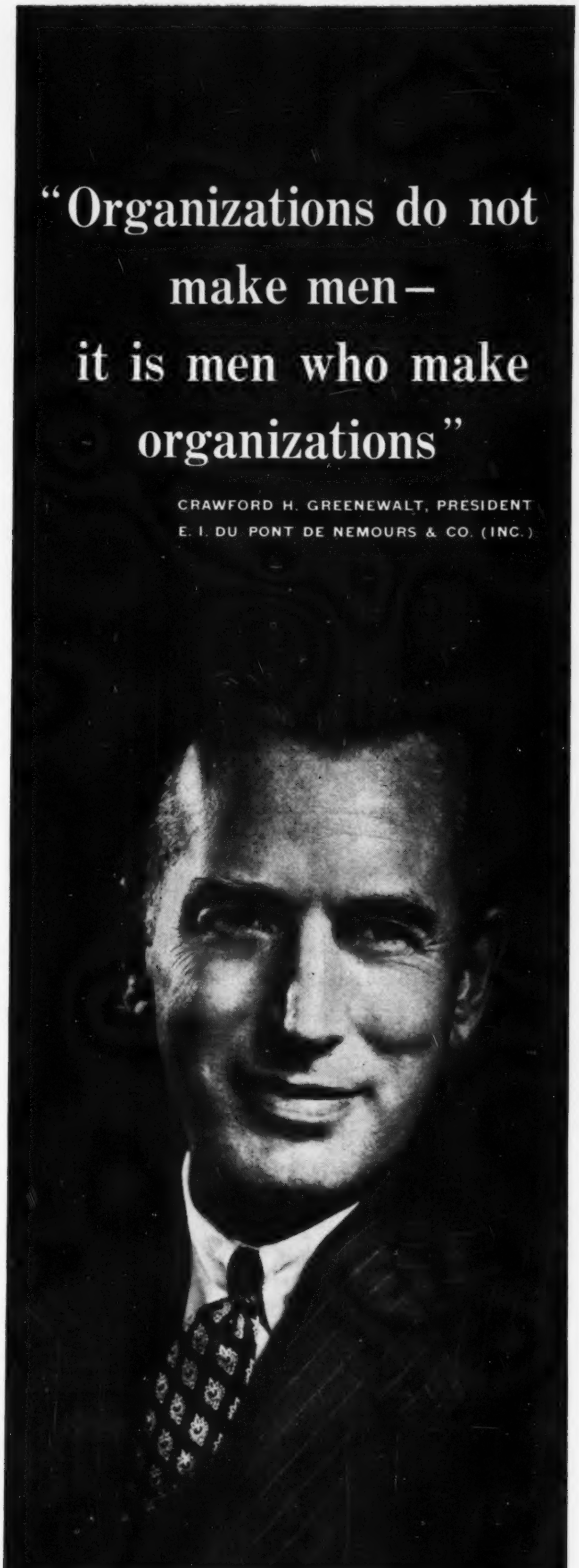
The best refrigerant proposed is the low molecular-weight hydrocarbon iso-butane, C_4H_{10}. In the Olin Hall experiments, iso-butane is not being used because of the great fire and explosion hazards attendant on its use. Instead, nonflammable chlorinated hydrocarbons are used. A minor difficulty in the use of these chlorinated refrigerants has been the formation of water-hydrocarbon compounds, or hydrates. The compounds are crystals which can clog pipes. Hydrate complications are not expected from iso-butane.

Toward the Future

Whether the system will be used on a large scale will depend on many factors: efficient compression, corrosion problems, investment cost, labor, maintenance, and power costs. After his study is completed, Professor Wiegandt says it is up to the Government to authorize the building of a pilot plant to pursue the matter further.

Assisting Professor Wiegandt are Messrs. Jay Markley, and Charles Krutchen, grad students, and Mr. John Slack, 5th year chemical engineering student.

by William J. Krossner, ChemE '61



"It is what men bring with them in the way of character and adaptability and fresh ideas that enriches the organizational bloodstream and insures corporate longevity." This is the observation of Crawford H. Greenewalt, President of the Du Pont Company.

In a lecture given in the past year at Columbia University, Mr. Greenewalt outlined his views on the role of the individual in the organization. "The Du Pont Company's success over the last 150 years," he pointed out, "has come about in large part through devoted allegiance to two major themes . . .

"First, the realization that an enterprise will succeed only to the extent that all individuals associated with it can be encouraged to exercise their highest talents in their own particular way.

"Second, the provision of maximum incentives for achievement, particularly in associating the fortunes of the individual to that of the corporation.

"Men are not interchangeable parts, like pinion gears or carburetors. Individuals differ in approach and method, and, to perform to best advantage, they must never be fettered to approaches and methods not their own."

"Conformity" obviously takes a back seat here. As Mr. Greenewalt comments, "We conform as is necessary to good manners, good relationships and the highest use of individual talent. And bear in mind that these are strictures on behavior, not on creative thought."

If you find this kind of atmosphere challenging it will pay you to explore career opportunities with Du Pont.

DU PONT
REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

STRESS *and* STRAIN...

E.E.: "Are you the barber who cut my hair last time?"

Barber: "I don't think so; I've only been here six months."

• • •

Ah, pity the Stress and Strain editor,
The man with the scissors and paste;
Oh, think of the man who must read all the jokes
And think of the time that he wastes.
He sits at his desk until midnight,
How worried and pallid he looks,
As he scans through the college comics
And reads all the comical books.
This joke he can't clip—it's too dirty.
This story's no good—it's too clean.
This woman won't do—she's too shapely.
This chorus girl's out—it's obscene.
The jokes are the same; full of Coeds
And guys who get drunk on their dates,
Bathtubs and sewers and freshmen,
And stories of unlawful mates.
Jokes about profs and the readers,
Jokes about overdue bills,
Jokes about girls in their boudoirs,
And each one as old as the hills.
Sprinkled with "damn," "louse" and "hell,"•
The blurbs must be pure but yet filthy
Oh pity the man with the clipper,
He's only a pawn and a tool.
In trying to keep his jokes dirty and clean
He's usually kicked out of school.

• • •

Professor: A fool can ask more questions than a wise man can answer:

Student: "No wonder so many students fail your exams."

• • •

Soph.: "I failed my Physics exam."

Jr.: "But I thought you had the answers written on your cuff."

Soph.: "Yeah, but by mistake I put on my calculus shirt."

He: "There are an awful lot of girls who don't want to get married."
Him: "How do you know?"
He: "I asked them."

• • •

In an effort to illustrate the value of non-technical electives for engineering students, the CORNELL ENGINEER presents the following quotations from literary masters with accurate translations:

On Imports:

Shakespeare: ". . . an unlessoned girl, unschooled, unpracticed: Happy in this she is not yet so old But she may learn."

Merchant of Venice

(Translation: A bit naive perhaps, but the gin will warm her up.)

On Drinking:

Thackeray: "Did ye iver try a brandy cocktail . . . ?"

The Newcomes

(Translation: Would you care for a glass of brandy?)

Shakespeare: "We'll teach you to drink deep ere you depart."

Hamlet

(Translation: Would you care for a glass of scotch?)

Milton: "One sip of this—Will bathe the drooping spirits in delight—Beyond the bliss of dreams."

Comus

(Translation: Would you care for a glass of champagne?)

Shakespeare: "Come, come, good wine is a good familiar creature, if it be well used; exclaim no more against it."

Othello

(Translation: What *would* you care for?)

(Alternative translation: You *do* drink, don't you?)

(Second alternative translation: What the hell do you expect to *do* all week-end?)

On Its Relation to the Academic Life:

Francis Bacon: "'Tis impossible to love and to be wise."

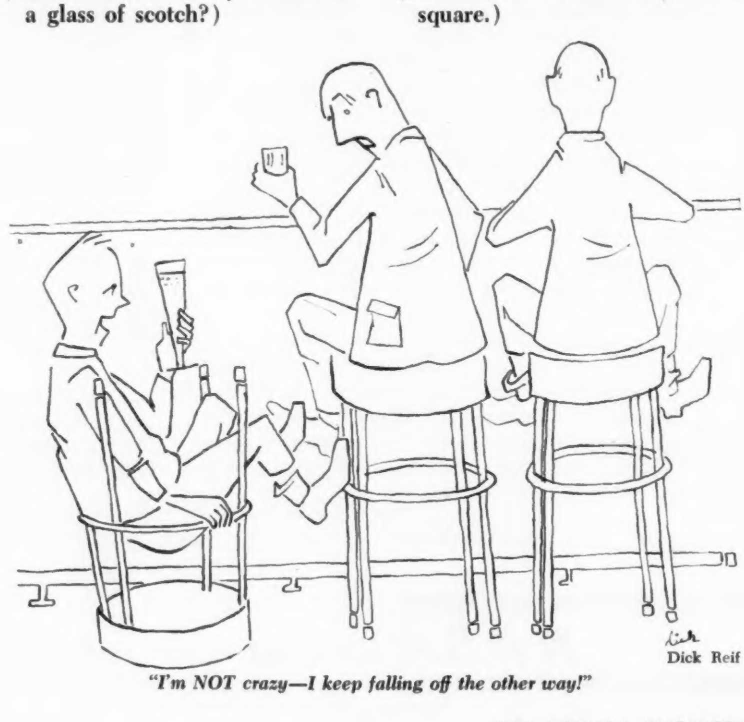
Essays: Of Love

(Translation: He who parties it up too much busts out too soon.)

Byron: "Let us have wine and women, mirth and laughter, Sermons and soda-water the day after."

Don Juan

(Translation: Francis Bacon is a square.)



"I'm NOT crazy—I keep falling off the other way!"